March 1978
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Mariners Weather Log

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Cover: This picture postcard photo of the harbor on Tangier Island on the Chesapeake Bay shows the USCGC CLOCH making its way through the ice to break out the island supply boat on February 8, 1978. Wide World Photo.

Mariners Weather Log

Editor: Elwyn E. Wilson
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Routing
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PLEASE PASS THIS ISSUE ALONG

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget through June 30, 1980.

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Mariners Weather Log

KAOHSIUNG, TAIWAN, AS A TYPHOON HAVEN

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Editor's Note: This is the third in a series of articles evaluating the safety of ports as shelters from tropical cyclones. These are edited versions of studies that appear in the Typhoon Havens Handbook for the Western Pacific and Indian Oceans by Samson Brand and Jack W. Bielloch, June 1976, Naval Environmental Prediction Research Facility, Monterey, Calif.

The question of Kaohsiung as a haven from typhoons was answered in July 1977. Typhoon Thelma devastated the port with her 86-kn sustained winds and torrential rains. All eight of the port's container-handling cranes were demolished, and 32 vessels were sunk. The U.S. tanker GAINES MILL, in tow to Taiwan for breakup, capsized and grounded near the port. In the harbor the CHENG LUNG overturned (fig. 1) and

Figure 1.--The battered 3,000-ton oil tanker CHENG LUNG lies on her side as a result of typhoon Thelma's assault on the port of Kaohsiung. United Press International Photo.

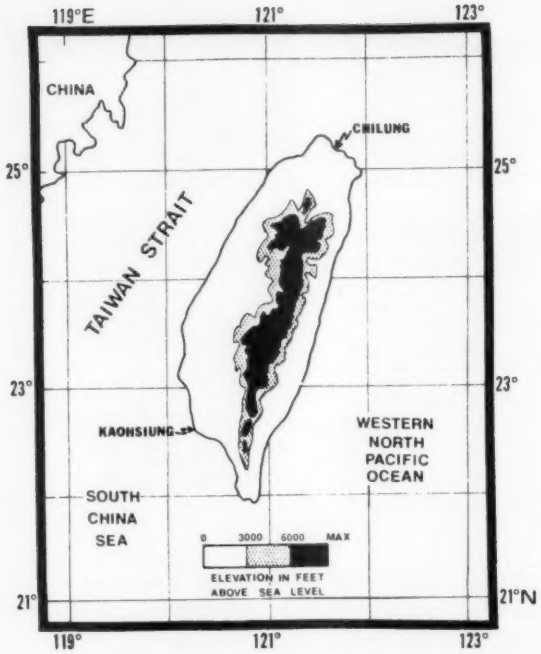

Figure 2.--Topographic map of Taiwan showing the location of Kaohsiung and approximate elevations above sea level.

the FRESNO CITY sustained serious damage.

THE SETTING

Taiwan is a rugged island with well over half of its land area composed of mountainous terrain (fig. 2). The major mountain ranges are oriented north-south and run nearly the entire length of the island. These mountains pose a significant barrier to the circulation of tropical cyclones passing close to or crossing Taiwan.

The port city of Kaohsiung is located at the southern end of the west coast of Taiwan. The city is built on the western edge of a broad alluvial plain that extends east/west for 20 mi. Directly east of Kaohsiung is the southern extremity of the central mountain range. These mountains play an important role in modifying the weather at Kaohsiung.

Kaohsiung harbor is divided into two portions, an outer and an inner harbor (fig. 3). The outer harbor, used for temporary anchorage, is protected by breakwaters extending westward on the north and south. The inner harbor lies in a southeasterly direction between the coastal plain and a long, low, sandy peninsula. The inner harbor is approximately 9 mi long with a maximum width of 750 yd.[1] There are two entrances--the main entrance at the northwest end and a second entrance (presently under construction) approximately 5 mi southeast of the main entrance. The date of completion of the second entrance is unknown at this time. The northern entrance is extremely narrow, the width being less than 150 yd at one point. Because of the congested nature of Kaohsiung harbor and its restricted entrance, pilotage is normally required for arrival and departure of all vessels.

THE CLIMATOLOGY

While tropical cyclones can develop during any

[1]Kaohsiung harbor is presently undergoing an extensive construction program. For this reason any statements as to facilities and or dimensions are subject to change in the near future.

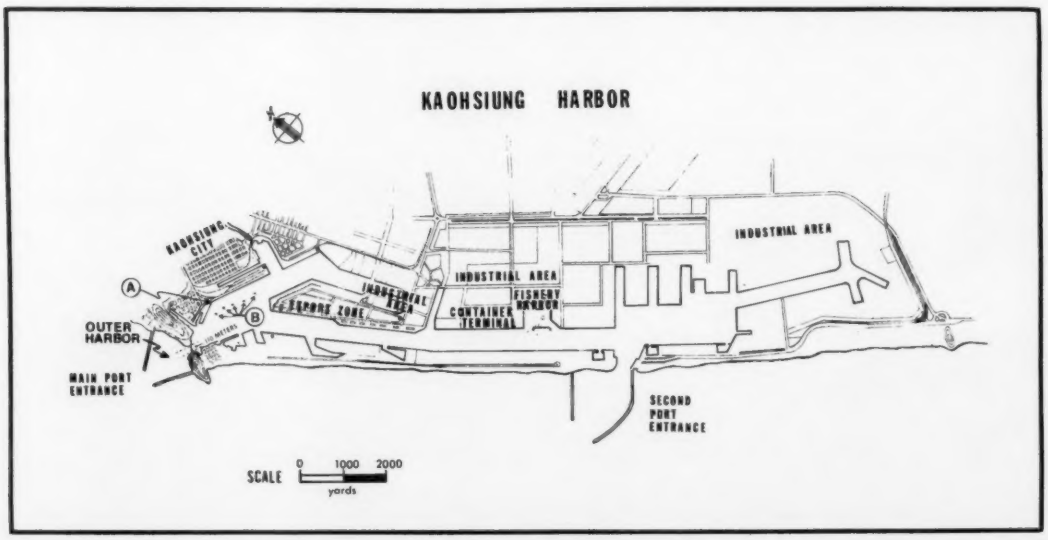

Figure 3.--Kaohsiung harbor showing the locations of piers (A) and buoys (B) which are normally assigned to U.S. Navy ships. Container terminal for commercial ships is clearly marked. (Kaohsiung Harbor Bureau, 1973).

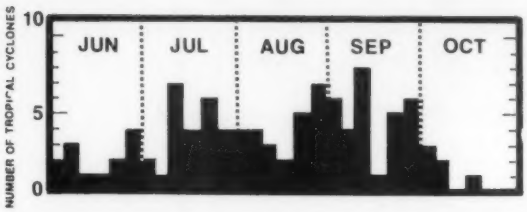

Figure 4.--Frequency distribution of the number of tropical cyclones that passed within 180 mi of Kaohsiung. Subtotals are based on 5-day periods for tropical cyclones that occurred during 1949-72.

month of the year, the majority pose a threat (approach within 180 mi) from June through October. From 1949-72, 98 tropical cyclones (tropical storms and typhoons) threatened Kaohsiung--an average of 4 per year. The largest number in any single season was six. The frequency of these storms is highest from July through September (fig. 4). Approximately 60 percent of these tropical cyclones pass to the south, while the other 40 percent pass to the north. Most approach from the southeast (fig. 5). Of the 98 tropical cyclones, only 28 generated winds of 34 kn or greater at Kaohsiung.

Figures 6 through 10 give the percentage of tropical cyclones that have passed within 180 mi of Kaohsiung (can be interpreted as a probability of threat) for the months of June through October. The dashed lines represent approximate approach times to Kaohsiung based on an approach speed of 8 to 12 kn. For example, in figure 6 a storm at 130°E, 12°N, has a 60-percent probability of passing within 180 mi of Kaohsiung, and if its speed remains in the 8- to 12-kn range, it will reach Kaohsiung in about 3 to 4 days (the faster the speed of an individual storm, the shorter the time required to reach Kaohsiung). The average speed of typhoons approaching Taiwan has been determined to be 10 to 11 kn (Brand and Blelloch, 1973).

THE PROBLEM

Tropical cyclones that generate gales at Kaohsiung generally fall into two categories: those that cross Taiwan north of Kaohsiung, and those that pass to the south or southwest within 180 mi of Kaohsiung. This difference is the key factor in determining to what extent an individual storm will affect Kaohsiung and how much time must be allowed for evasion. If the storm path is north or northeast of Kaohsiung across Taiwan, the storm will lose much of its intensity through interaction with the land prior to affecting the Kaohsiung area. For this reason, even fully developed typhoons passing north of Kaohsiung have at times little effect on the harbor. An example of this was typhoon Agnes (September 1971) which crossed Taiwan 50 mi north of Kaohsiung. When Agnes approached the east coast of Taiwan, maximum winds were reported at 70 kn; within 12 hr, as the storm crossed the island, the maximum winds had decreased to 40 kn. Throughout this period the winds at Kaohsiung did not exceed 24 kn.

In the case of a storm passing south or southwest of Kaohsiung, the path of the storm is entirely over water, and the storm reaches its closest point of approach to

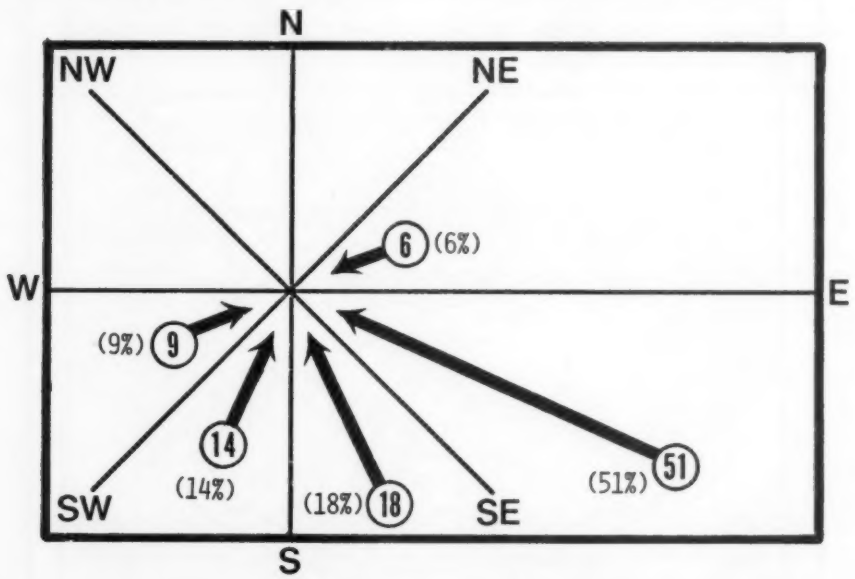

Figure 5.--Direction of approach to Kaosiung of the tropical cyclones (1949-72) that passed within 180 mi of Kaohsiung. Circled numbers indicate the number that approached from each octant. The number in parentheses is the percentage of the sample (98) that approached from that octant.

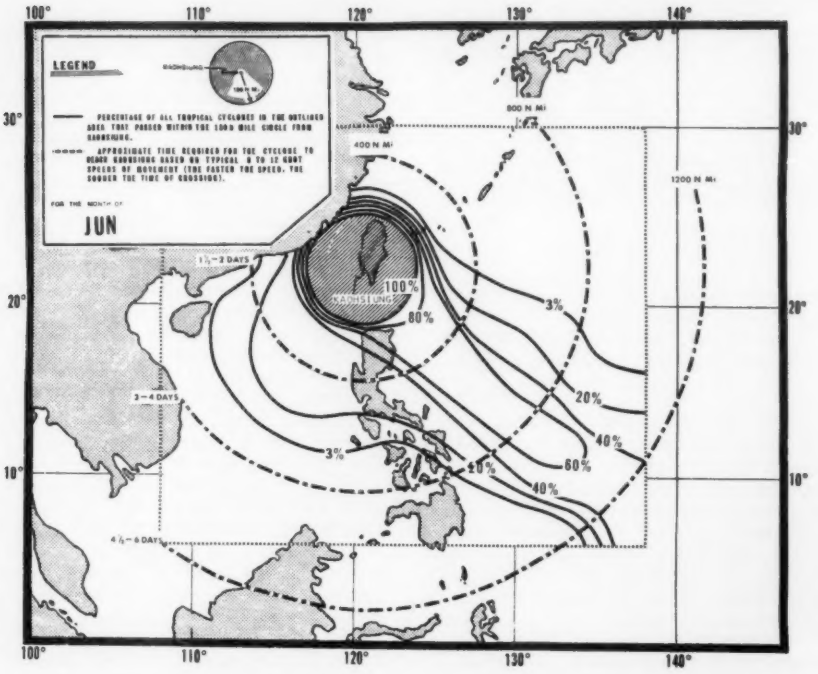

Figure 6.--Probability that a tropical cyclone will pass within 180 mi of Kaohsiung in June (based on data from 1884-1972).

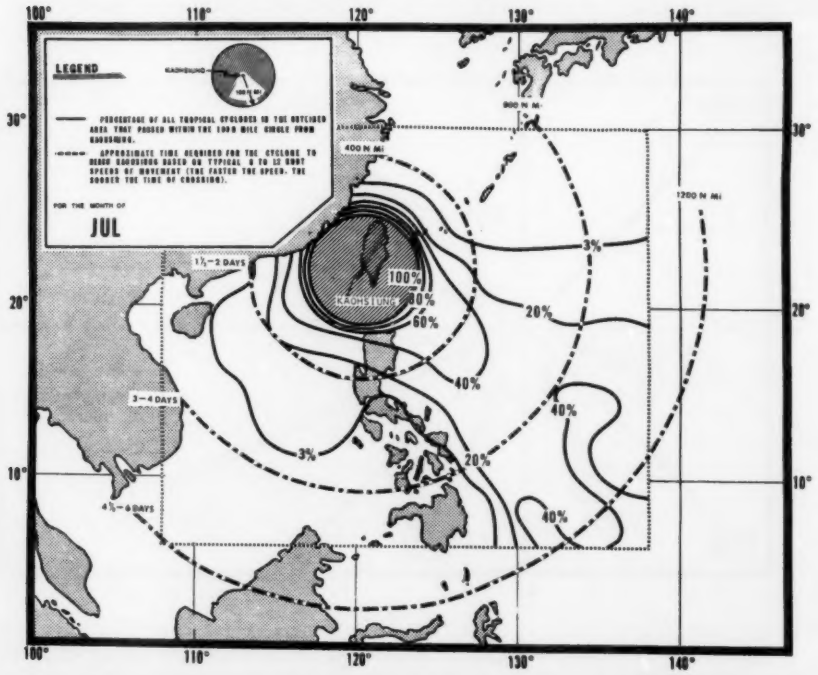

Figure 7.--Probability that a tropical cyclone will pass within 180 mi of Kaohsiung in July (based on data from 1884-1972).

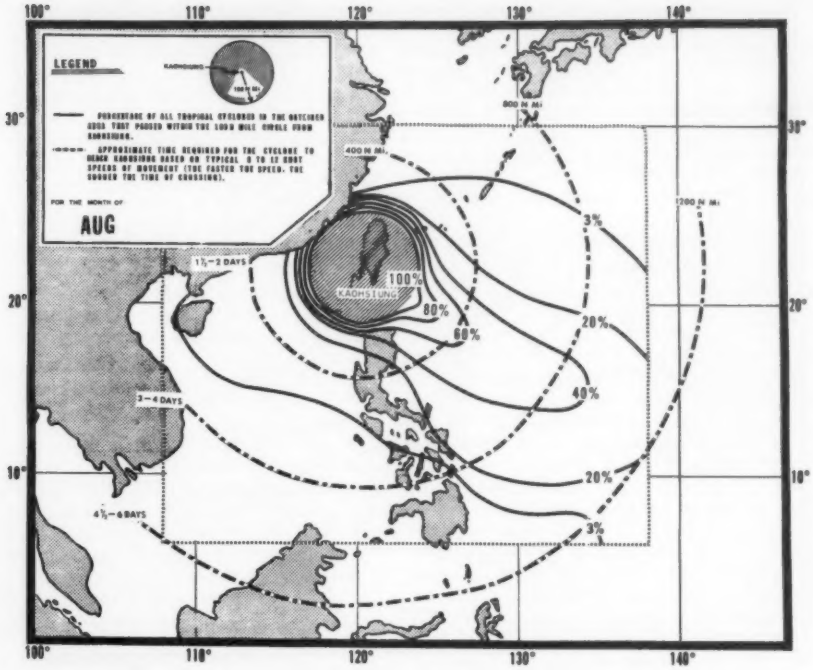

Figure 8.--Probability that a tropical cyclone will pass within 180 mi of Kaohsiung in August (based on data from 1884-1972).

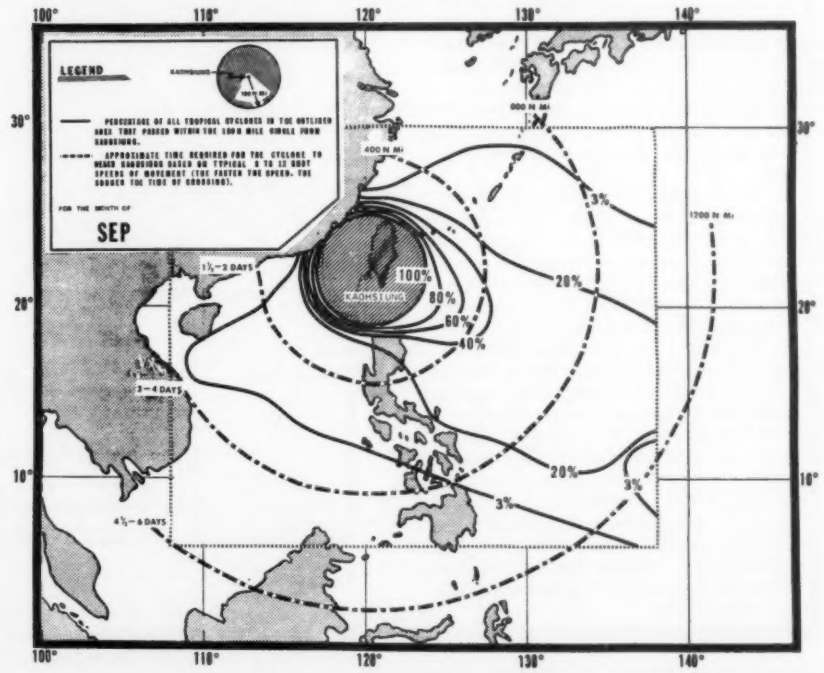

Figure 9.--Probability that a tropical cyclone will pass within 180 mi of Kaohsiung in September (based on data from 1884-1972).

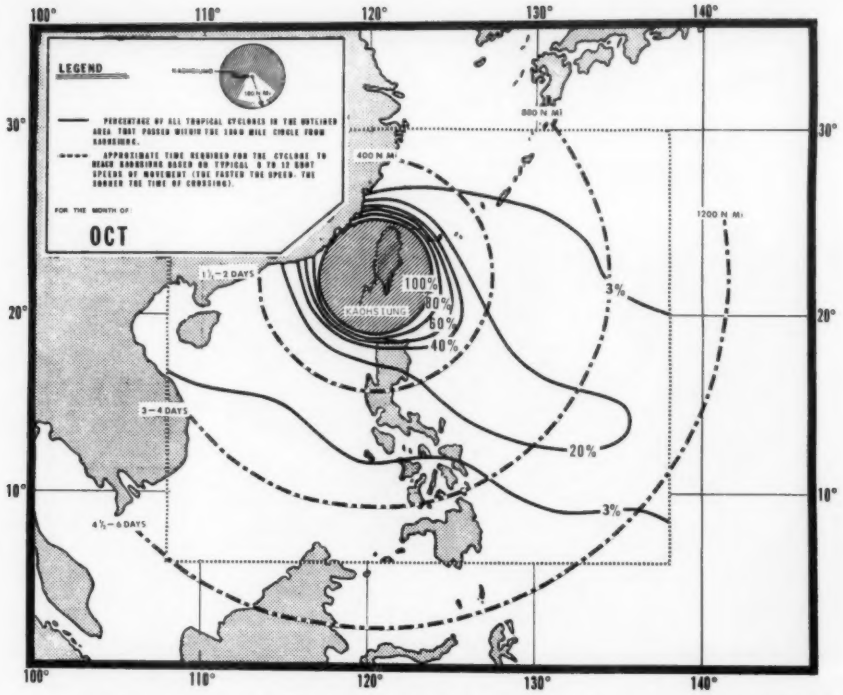

Figure 10.--Probability that a tropical cyclone will pass within 180 mi of Kaohsiung in October (based on data from 1884-1972).

Kaohsiung at or near full intensity.[2] This type of approach also places Kaohsiung in the "dangerous" or right semicircle of the storm often subjecting the harbor to the highest wind velocities. An example was typhoon Viola (July 1969). Viola's eye passed well to the south of Kaohsiung, the closest point of approach being more than 120 mi to the south, yet the wind at Kaohsiung reached 47 kn.

Wind reports for 29 yr (1949-77) showed only one observation that exceeded 65 kn. While this is a very substantial velocity, it is somewhat below what might be expected in view of the unprotected southern approaches to Kaohsiung harbor and its history of frequent storm occurrence. In addition, the potential for disastrous winds was dramatically pointed out in July 1977 with typhoon Thelma and her associated 86-kn winds which devastated the port. These winds are the highest in the entire record of Kaohsiung. The mountain ranges east of Kaohsiung (fig. 2) are one explanation for the low frequency of high winds. It is thought that the mountains disrupt the circulation of storms approaching from most quadrants, thereby limiting surface windspeeds in the Kaohsiung area. The sheltering effect is also evident in figure 11, which shows the positions of tropical-cyclone centers when windspeeds first and last exceeded 33 kn at Kaohsiung. Notice that storms passing to the north affect Kaohsiung for a shorter period than those passing to the south.

Kaohsiung inner harbor experiences only minor wave

Figure 11.--Positions of tropical-cyclone centers when winds of 34 kn or more were first and last observed at Kaohsiung (based on data from 1949-72).

action during typhoon passage owing to the confined nature of the harbor with its small area. However,

[2]Some storms may have crossed the Philippines but have had a transit over water of sufficient length to regain most of their pre-Philippine intensity.

the currents and sea state outside Kaohsiung harbor have been a significant threat to ships attempting to enter or leave the harbor prior to the onset of typhoon conditions. One explanation for this problem is shoaling. The water depth decreases rapidly from 6,000 ft to less than 200 ft southwest of Taiwan. It is this rapid shoaling which causes the high sea states observed outside Kaohsiung harbor prior to and during typhoon passage. This expected wave action should be considered if a sortie becomes necessary.

Storm surge can be defined as the difference in observed water level at a given location during the storm and nonstorm conditions. There are no records of storm surge occurring in Kaohsiung harbor, and conversations with the Harbor Bureau Engineering Staff indicate that, if it does occur, it is very minor and hence poses no serious problem for shipping inside the harbor boundaries.

There are operational characteristics that make the harbor dangerous during storm conditions. Located at the southern extreme of the harbor is a ship-scrapping facility ("industrial area" on fig. 3), where ships scheduled for scrapping such as the GAINES MILL are beached and left unattended for extended periods. During the passage of tropical cyclones the combination of wind and wave action has refloated some of these derelicts, which then moved through the harbor causing considerable damage to other vessels.

Another aspect of Kaohsiung harbor that must be taken into account is the civilian ships present in the harbor. Port authorities emphasized that the mooring equipment (lines, cables, etc.) of the merchant ships present is not always adequate for storm conditions. As a result, it is not uncommon for ships to break loose during high winds and damage adjacent ships. It is obvious that in a crowded harbor such as Kaohsiung any ship out of control or drifting is an extreme danger.

THE DECISION

Remaining in port is not the recommended course of action when typhoon conditions threaten Kaohsiung. Due to the confined nature of the harbor and the difficulty experienced in maneuvering in strong winds, the ship should be ready to get underway before the storm center approaches within 400 mi. If this general rule is followed, more than enough time will be available to clear Kaohsiung harbor before the wind reaches 20 kn. If the storm approaches within 350 mi before the sortie is complete, the winds and seas outside the harbor could lower the ship's speed of advance.

A most important aspect of any decision concerning heavy weather is an early appraisal of the threat posed by an individual tropical cyclone. Preparation should begin when enough time remains to allow flexibility in the evasion plan. To facilitate early action, the following time table (in conjunction with figure 12) has been set up.

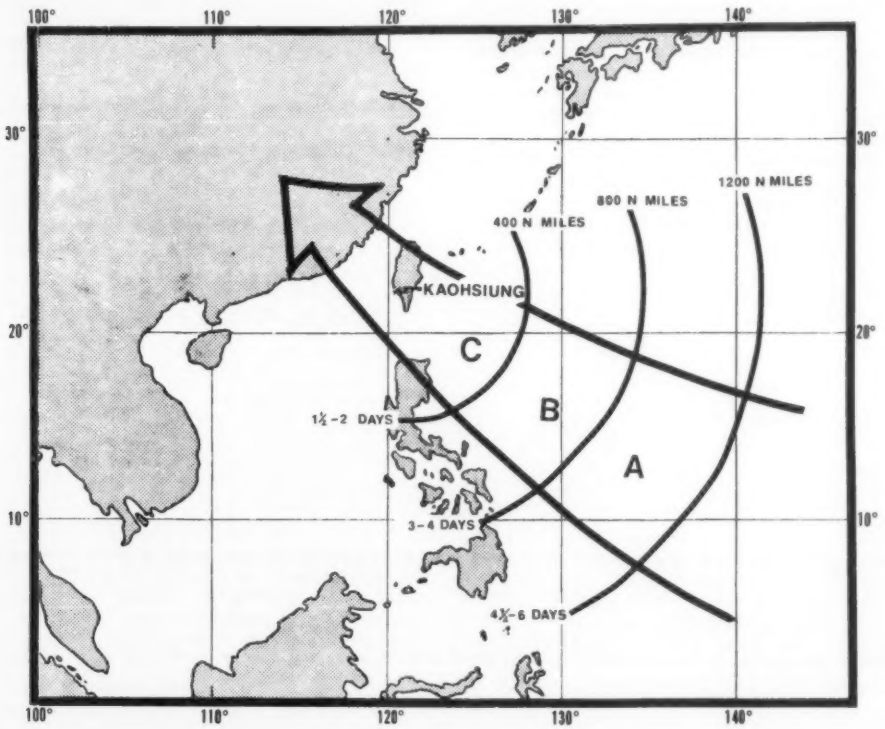

Figure 12.--Tropical cyclone threat axis for Kaohsiung. Distance and approach times are measured from Kaohsiung based on 8- to 12-kn speed of movement.

1. An existing tropical cyclone moves into or development takes place in Area A with forecast movement toward Kaohsiung:

   a. Review material condition of ship. A sortie may be desirable within 2 to 4 days.

   b. Reconsider any maintenance that would render the ship incapable of getting underway within 48 hr.

2. Tropical cyclone enters Area B moving toward Kaohsiung:

   a. Plan course of action to be taken within 1 to 2 days.

   b. Reconsider any maintenance that would render the ship incapable of getting underway within 24 hr.

3. Tropical cyclone enters Area C moving toward Kaohsiung:

   a. Execute evasion plans.

THE EVASION

Evasion at sea is the preferred course of action when confronted with typhoon conditions at Kaohsiung. The captain with his knowledge and experience makes the final decision, and the following information is only intended as a guide.

Evasion through the Taiwan Strait is not recommended due to the violent sea state and strong winds that are likely to be encountered there. Also crossing ahead of an approaching typhoon is hazardous and must be accomplished well ahead of the storm. In attempting to cross ahead of a storm, if the ship is caught in the high sea and swell pattern, the speed of advance may be reduced to the point that the ship will be unable to maneuver clear of the storm. In addition, it is very possible during the peak typhoon season for rapid storm development to occur, resulting in two or more storms coexisting in the western Pacific area. This possibility would complicate the evasion problem and should be kept in mind as evasion plans are being made and carried out.

For the more common threat situations these evasion techniques are suggested:

1. Tropical cyclone approaching from the southeast and forecast to pass north or east of Kaohsiung:

   Evasion should be to the south into the South China Sea. The ship will be in the safe or navigable semicircle with following wind and sea.

2. Tropical cyclone approaching from the southeast and forecast to pass south of Kaohsiung:

   Evasion should be south into the South China Sea. In this case, the evasion route crosses ahead of the typhoon.

3. Tropical cyclone approaching from the South China Sea:

   Evasion should be southeast into the Pacific Ocean.

Remaining in port is not recommended when typhoon conditions threaten Kaohsiung. If for any reason the ship must remain in port, the following points should be considered:

1. Secure to a pier or a buoy before the wind reaches 20 kn in order to avoid undue difficulty.

2. There are no sheltered berths in Kaohsiung harbor.

3. Once the heavy weather begins, the confined harbor with its narrow entrances precludes getting underway until weather conditions abate.

REFERENCES

Brand, S. and J. Blelloch, 1973: "Changes in the characteristics of typhoons crossing the island of Taiwan." ENVPREDRSCHFAC Tech. Paper No. 8-73.

Kaohsiung Harbor Bureau, 1973: Port of Kaohsiung. Kaohsiung, Taiwan, Republic of China, 28 pp.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

NORTH ATLANTIC TROPICAL CYCLONES, 1977

Miles B. Lawrence
National Hurricane Center, NOAA
Miami, Fla.

The North Atlantic hurricane season was rather inactive in 1977. There were six named tropical cyclones, of which five reached hurricane force. This compares with a long-term average of nine storms per year, including five hurricanes. Table 1 gives a statistical summary of the 1977 storms, and figure 13 shows their tracks.

Another measure of activity is the number of hurricane days. There were only 9 hurricane days this season. The annual average is 29 hurricane days. The impact of such inactivity on mariners is suggested by table 2, which is a list of ships encountering tropical cyclones during 1977. There are only 43 ships on this list. In 1976 there were 26 hurricane days, and 151 ships encountered gale-force winds or higher in connection with tropical cyclones.

Hurricane Anita was named on August 29. Fewer than 10 percent of the hurricane seasons have begun this late. The season terminated when tropical storm Frieda moved inland on October 18. This 51-day interval compares with the average length of time of 110 days between beginning and ending dates. Tables 3 and 4 show the frequency of tropical cyclones during past years and loss of life and damage.

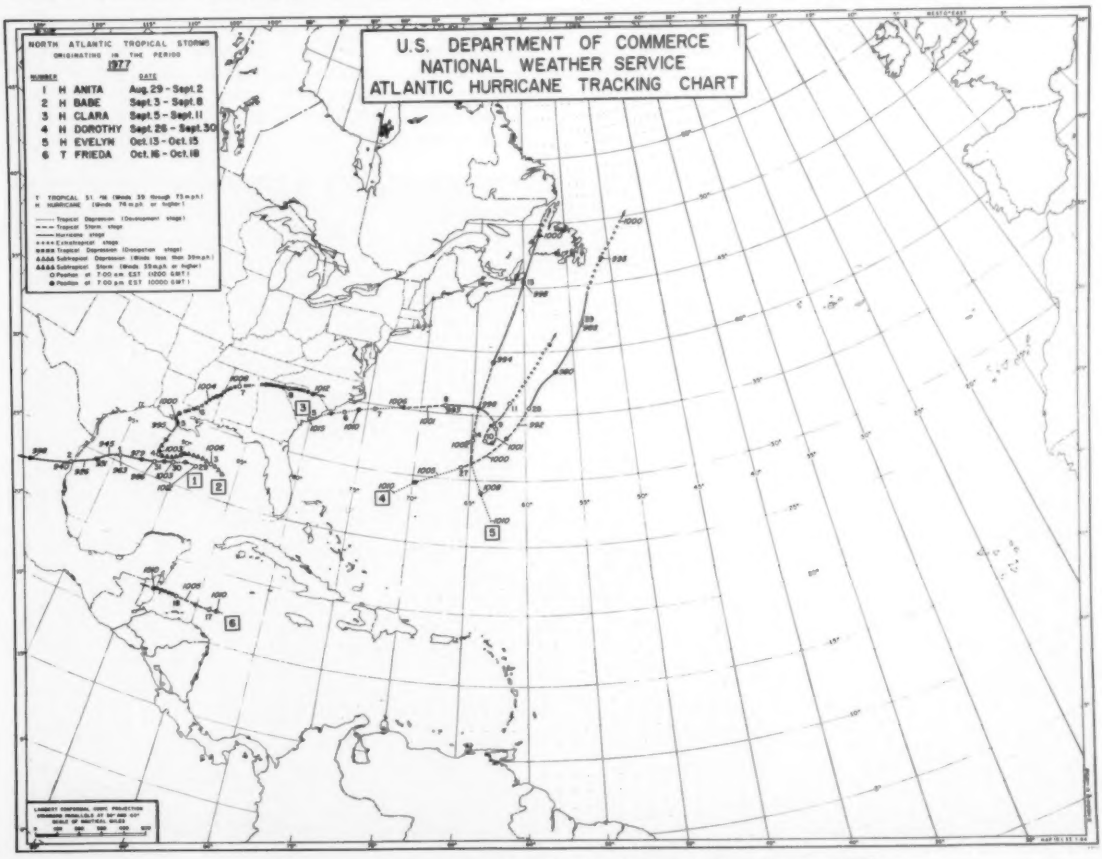
U.S. DEPARTMENT OF COMMERCE
NATIONAL WEATHER SERVICE
ATLANTIC HURRICANE TRACKING CHART
NORTH ATLANTIC TROPICAL STORMS
ORIGINATING IN THE PERIOD
1977
NUMBER
DATE
1 H ANITA Aug. 29 - Sept. 2
2 H BABE Sept. 3 - Sept. 8
3 H CLARA Sept. 5 - Sept. 11
4 H DOROTHY Sept. 26 - Sept. 30
5 H EVELYN Oct. 13 - Oct. 15
6 T FRIEDA Oct. 16 - Oct. 18

Figure 13.--Tracks of North Atlantic tropical cyclones, 1977.

Table 1.--Summary of North Atlantic tropical cyclone statistics, 1977

No.	Name	Class	Dates	Maximum sustained winds (kn)	Lowest pressure (mb)	U.S. damage ($ million)	Deaths
1	Anita	H	Aug. 29-Sept. 2	150	926	minor	Mexico, 10
2	Babe	H	Sept. 3-8	65	995	10	
3	Clara	H	Sept. 5-11	65	993		
4	Dorothy	H	Sept. 26-30	75	980		
5	Evelyn	H	Oct. 13-15	70	994		
6	Frieda	T	Oct. 16-18	50	1005		

Table 2.--Ships encountering tropical cyclones in the North Atlantic during 1977

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C		Sea Waves +		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°	Speed kt.				Air	Sea	Period sec.	Height ft.	Dir. 10°	Period sec.	Height ft.
ANITA		AUG															
SHIP		29	28.2	88.0	12	10	34			1015.2			04	3	13	6	8
SEALAND PRODUCER	U.S.A.	29	26.2	87.8	23	18	44			1009.8			"Very Rough"				
MARINE DUVAL	U.S.A.	30	27.8	88.8	00	14	37			1012.5							
ASMARA	U.S.A.	30	25.4	90.9	21	25	44			1005.5							
SHIP		31	28.5	89.3	00	07	33			1011.2			04	5	18	7	10
ASMARA	U.S.A.	31	25.1	91.2	00	25	37			1016.5							
OGDEN JORDAN	LIBERIA	31	26.5	93.1	00	03	37			998.3			05	15	05	7	11
PRAIRIE GROVE	U.S.A.	31	27.1	86.4	00	14	35							10			
OGDEN JORDAN	LIBERIA	31	26.9	90.9	03	11	65			1001.3							
NEPTUNE CYPRINE	SINGAPORE	31	26.3	90.2	12	13	40			1007.0			03	10	13	8	13
BALTIMORE TRADER	U.S.A.	31	24.3	91.0	15	23	35			1010.2			03	10	34	8	16
GUADALUPE	U.S.A.	31	26.0	91.0	15	15	43			1011.6			10	18	15	10	18
YTTX	YUGOSLAVIA	31	26.8	89.6	15	14	48			1009.0			05	11			
BALTIMORE TRADER	U.S.A.	31	24.4	90.2	18	18	35			1011.0			04	13	14	8	16
GUADALUPE	U.S.A.	31	27.9	90.8	18	16	35			1012.2			05	8	15	8	16
NEPTUNE CYPRINE	SINGAPORE	31	26.8	90.5	18	13	35			1009.0			08	10	13	9	15
YTTX	YUGOSLAVIA	31	26.4	89.6	18	15	46			1009.5			24	8	05	6	38
		SEP															
TEXACO CONNECTICUT	U.S.A.	1	28.7	93.8	00	08	35			1010.8			05	5	12	9	10
EXXON FLORENCE	U.S.A.	1	28.5	93.3	12	11	35			1010.3							
DAVID P. REYNOLDS	LIBERIA	1	27.7	95.5	12	09	35			1007.8			05	11	09	8	13
TEXACO FLORIDA	U.S.A.	1	24.1	93.4	15	18	54			1000.9			03	7	20	6	7
DAVID P. REYNOLDS	LIBERIA	1	27.2	94.3	18	08	45			1009.0			05	11	10	9	13
DAVID P. REYNOLDS	LIBERIA	2	26.7	93.4	00	11	35			1010.8			05	11	11	6	11
YTTX	YUGOSLAVIA	2	22.7	96.5	06	19	37			1004.5			04	5	33	≥14	7
BABE		SEP															
KLEK	YUGOSLAVIA	3	28.7	89.4	18	05	37			1010.7			05	8			
KLEK	YUGOSLAVIA	4	29.7	88.7	00	08	44			1008.5			05	15			
CORSAIR		4	27.6	90.9	09	14	40										
MOBIL GAS	U.S.A.	4	27.7	90.6	15	17	34			1008.5			01	2	19	9	13
CITIESSERVICE BALTIMORE	U.S.A.	4	27.8	90.9	16	16	37			1010.2					14		17
MOBIL GAS	U.S.A.	4	28.0	91.4	18	14	35			1003.4			02	3	15	8	13
MOBIL FALCON	LIBERIA	4	27.1	90.2	18	17	46			1008.0							
SHIP		5	27.4	90.5	00	18	39			1004.7			07	8	22	9	15
CLARA		SEP															
NENC	U.S.A.	9	33.4	65.3	12	33	40			1013.9			04	15	34	≥14	30
GNGU	U.K.	11	34.9	58.4	16	24	44			1007.2			07	8	24	10	16
VAN HAWK	POLAND	11	37.9	56.1	18	21	43			1008.0							
DOROTHY		SEP															
HAHNENTOR	GERMANY	29	40.0	49.2	12	16	44			1007.6			07	16	16	10	20
MARITIME FORTUNE	PANAMA	29	41.9	47.4	18	16	39			1010.0			06	13	17	6	13
MUENCHEN	GERMANY	29	44.6	56.8	18	03	33			996.7			04	7	03	6	16
EVELYN		OCT															
STAR ASAHI	NORWAY	14	28.1	62.3	00	13	35			1016.0							
CHEVRON MADRID	NETHERLANDS	14	32.5	59.9	06	15	39			1018.7							
MARINE NAUTICA	SWEDEN	15	45.7	59.1	18	09	68			1001.0							
HLYO	KOREA	15	46.9	57.7	18	13	35			1002.5							
FRIEDA		OCT															
SHIP		18	16.2	85.2	06	26	35			1013.5							

+ Direction for sea waves same as wind direction

Another aspect of this season concerns the storm tracks. Figure 13 shows that none of the storms originated east of longitude 60°W. This situation has occurred only one other time (1972) during the past 30 yr. It is likely that the absence of activity across the tropical North Atlantic is related to the strength of the Bermuda-Azores high-pressure ridge, which was weaker than normal during September.

Anita reached a central pressure of 926 mb, the fourth lowest ever recorded in the Gulf of Mexico. Babe made landfall along the Louisiana coast and was the only named storm to directly hit the United States in 1977.

The author wishes to take this opportunity to note,

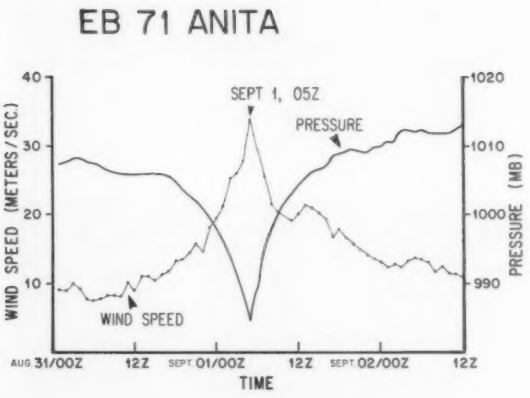

Figure 14.--Pressure and windspeed observations from NOAA data buoy EB-71 (26.0°N, 93.5°W).

again, that timely ship observations continue to play a vital role in the detection and tracking of dangerous storms at sea.

HURRICANE ANITA, AUGUST 29-SEPTEMBER 2

Anita was identified as a tropical depression at 1200 on August 29, centered a little over 200 mi south-southeast of New Orleans. Previously, the progress of a tropical wave had been followed across the Atlantic during mid-August. Cloudiness and rain associated with this system spread across the Bahamas, Florida, and western Cuba on the 25th through the 27th and moved into the eastern Gulf of Mexico on the 28th, where Anita's development began.

Anita traveled west-southwestward across the Gulf of Mexico for the next 4 days, steadily intensifying. Tropical-storm strength was reached just before 0600 on the 20th. Twelve hours later, hurricane force was reached. Intensification continued until a minimum pressure of 926 mb was measured just prior to landfall, which occurred early on September 2 along the Mexican coast about 150 mi south of Brownsville, Tex. Maximum surface winds reached 150 kn, and Anita has been ranked as the fourth most intense storm in the Gulf of Mexico, behind the 1935 Labor Day storm in the Florida Keys (892 mb), Camille in 1969 (905 mb), and Beulah in 1967 (923 mb).

More than half of the ships in table 2 took observations while within Anita's circulation. The OGDEN JORDAN reported hurricane-force winds at 0300 on August 31, when she was less than 40 mi north of the hurricane's center. The TEXACO FLORIDA measured southerly winds of 54 kn at 1500 on September 1, about 100 mi southeast of the center.

Three NOAA data buoys in the Gulf of Mexico were in position very close to Anita's path. The hurricane passed within 20 mi of data buoy EB-71 (26°N, 93.5°W) at 0500 on the 1st, and wind and pressure profiles from this buoy are shown in figure 14. EB-71 also reported significant wave heights of 23 ft.

Figure 15 is a visible satellite picture of Anita on the afternoon of the 1st, when maximum sustained winds were 100 kn. A radar picture taken at Browns-

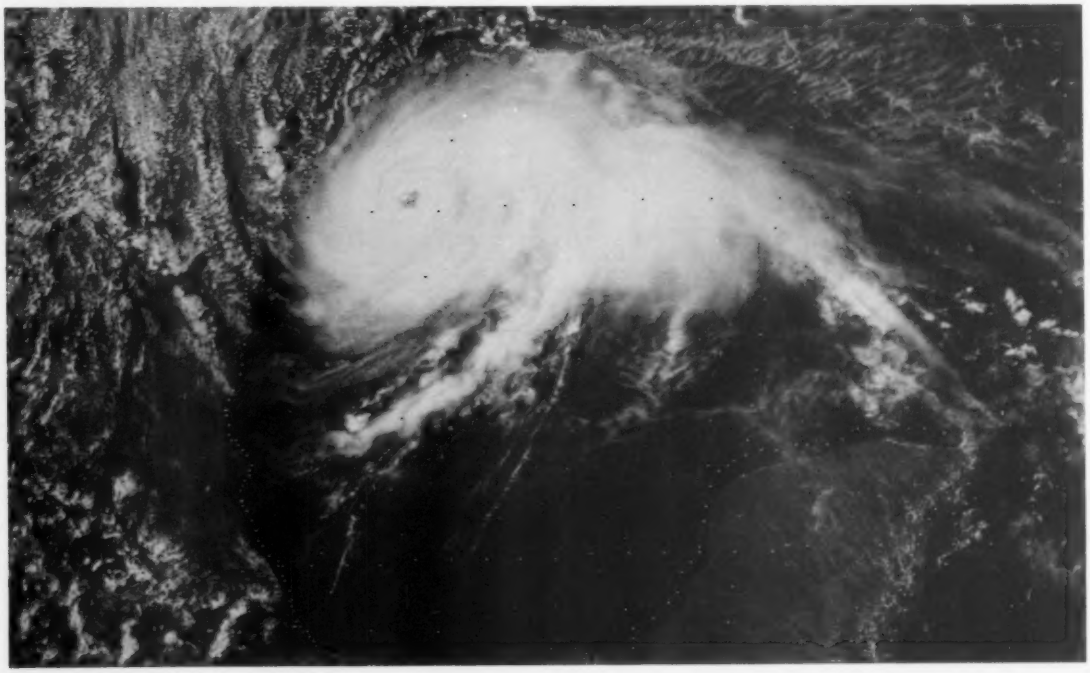

Figure 15.--Hurricane Anita on the afternoon of September 1, 110 mi southeast of Brownsville.

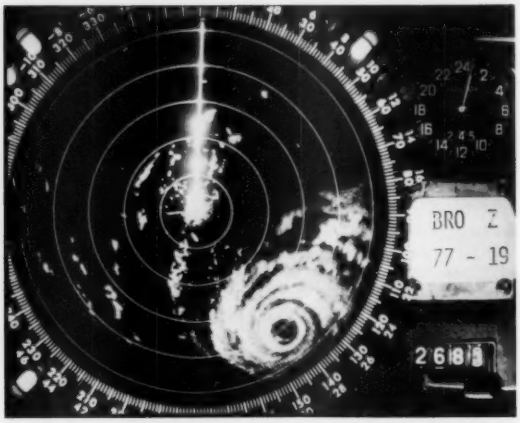

Figure 16.--Brownsville radar picture of Anita at 0100 September 2.

ville, Tex., at 0100 on September 2 is shown in figure 16; maximum winds are estimated at 140 kn.

Hurricane warnings were issued early on the 1st along the Texas coast from just south of Corpus Christi to Brownsville, and Mexican authorities were advised of the threatening nature of this storm. Landfall occurred along a sparsely settled region of the Mexican coast, and no damage estimates are available. Ten persons were reported dead from inland flooding and landslides in Mexico.

Almost 100,000 people evacuated low-lying areas in advance of the storm, including 7,000 workers from offshore-drilling platforms and 35,000 from Mexico. The remainder were from along the Texas and Louisiana coasts.

HURRICANE BABE, SEPTEMBER 3-8

On September 3 westerly surface winds reported from data buoy EB-44 (26°N, 86°W) confirmed the presence of a surface low-pressure system in the northeastern Gulf of Mexico. This depression was not far from the starting point of Anita (see fig. 13). The depression had formed as a result of the interaction between a tropical wave and a cold upper level low-pressure system.

Gale-force winds under a large band of convective cloudiness extended from the central Gulf of Mexico to the mouth of the Mississippi River, then eastward to just offshore near the Florida panhandle. The KLEK reported 37-kn winds under this cloud band. At 1600 on the 3d, Babe was named a tropical storm, and gale warnings were posted from Morgan City to Pensacola. Babe's structure was not yet completely tropical; however, upgrading to a tropical storm was done in order not to confuse the public during a warning situation.

On the 4th the transition to a tropical system was complete. The storm was moving northward, and reconnaissance aircraft reported 70-kn surface winds. Babe was upgraded to a hurricane, and warnings were posted along the Louisiana coast from Vermilion Bay eastward to the mouth of the Mississippi.

Postanalysis of the situation shows that the 70-kn wind was a transitory feature, and Babe did not act-

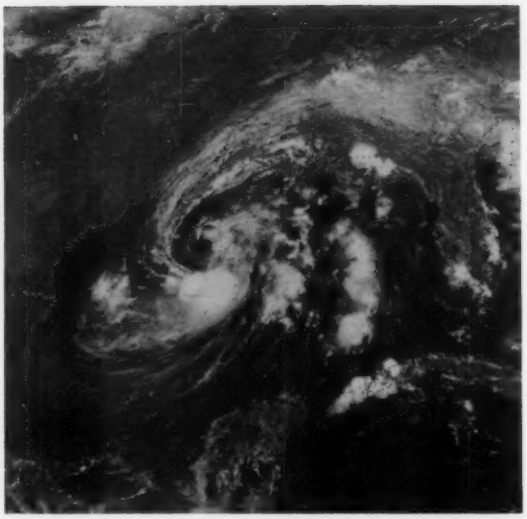

Figure 17.--Babe heading north toward Louisiana. Maximum sustained winds were 50 kn.

ually reach hurricane strength until 0600 on the 5th. Babe maintained hurricane status for only a few hours until she made landfall in south-central Louisiana on the morning of the 5th.

Figure 17 shows Babe on the afternoon of the 4th

Table 3
NORTH ATLANTIC TROPICAL CYCLONES FOR PAST YEARS

TOTAL NUMBER OF TROPICAL CYCLONES, LOSS OF LIFE AND DAMAGE

Year	Total Number Tropical Cyclones* All Areas	Total Number Tropical Cyclones* Reaching U.S. Coast	Total Number Hurricanes All Areas	Total Number Hurricanes Reaching U.S. Coast	Loss of Life Total All Areas	Loss of Life United States	Damage by Categories** Total All Areas	Damage by Categories** United States
1931	9	2	2	0		0		4
1932	11	5	6	2		2		4
1933	21	7	9	5		63		7
1934	11	5	6	3		17		6
1935	6	2	5	2		416		7
	58	21	28	12				
1936	15	7	7	3		9		6
1937	9	4	3	0		0		4
1938	8	4	3	2		600		5
1939	6	3	3	0		3		3
1940	9	3	4	2		51		6
	46	21	20	7				
1941	6	4	4	2		10		7
1942	10	3	6	2	17	0	7	7
1943	10	4	6	3	19	10	7	7
1944	11	4	7	3	1,076	64	8	8
1945	11	5	6	3	29	7	8	8
	48	20	29	13				
1946	6	0	3	1	5	0	7	7
1947	9	7	5	3	72	50	6	6
1948	9	4	6	3	24	3	7	7
1949	13	3	7	3	4	4	8	8
1950	13	4	11	3	27	10	7	7
	50	22	32	12				
1951	10	1	6	0	244	0	7	6
1952	7	2	0	1	16	3	6	6
1953	14	6	6	2	3	2	7	7
1954	11	4	6	3	720+	193	9	9
1955	12	5	9	3	1,518+	218	9	9
	54	18	27	9				
1956	9	2	4	1	76	21	8	7
1957	8	0	3	1	475	395	8	8
1958	10	1	7	0	49	2	7	7
1959	11	7	7	3	57	24	7	7
1960	7	3	4	2	185	65	8	8
	44	20	25	7				
1961	11	3	8	1	345	46	8	8
1962	9	1	3	0	4	4	6	6
1963	10	1	7	1	7,236+	11	9	7
1964	12	0	6	4	266	49	9	9
1965	6	2	4	1	76	75	9	9
	48	13	28	7				
1966	11	3	7	2	1,046	54	8	7
1967	9	2	5	1	89	15	8	8
1968	7	3	4	1	11	9	7	7
1969	18	3	10	2	265	256	9	9
1970	7	4	3	1	74	11	9	8
	46	14	30	7				
1971	12	5	9	3	44	5	8	8
1972	4	2	3	1	128	121	9	9
1973	7	1	4	0	16	3	7	7
1974	7	1	4	1	3,000+	1	8	8
1975	8	1	6	1	80	21	9	9
	38	11	26	6				
1976	8	2	6	1	77	9	8	8
1977	6	1	5	1	10	3	7	7
Total	441	163	258	81				
Mean	9.4	3.5	5.5	1.7				

**The Environmental Data Service has for some time recognized that, without detailed expert appraisal of damage, all figures published are merely approximations. Since errors in dollar estimates vary in proportion of the total damage, storms are placed in categories varying from 1 to 9 as follows:

1 Less than $50
2 $50 to $500
3 $500 to $5,000
4 $5,000 to $50,000
5 $50,000 to $500,000
6 $500,000 to $5,000,000
7 $5,000,000 to $50,000,000
8 $50,000,000 to $500,000,000
9 $500,000,000 to $5,000,000,000

*Including hurricanes
Not reported in literature, believed minor.
+ Additional deaths for which figures are not available.

with maximum sustained winds near 50 kn. Several ships at this time were within 100 mi of the storm center and reporting gales. These included the MOBIL GAS, MOBIL FALCON, and CITIES SERVICE BALTIMORE.

A 40-kn reading from Boothville was the highest sustained wind from a land station, although higher speeds probably occurred closer to the center. Tide readings along the Louisiana coast were up to 5 ft mean sea level (MSL), but some of this was due to Anita's recent passage. An estimate of $10 million in damages has been made. There are no known fatalities in connection with Babe.

HURRICANE CLARA, SEPTEMBER 5-11

Clara's origins can be traced to a convective cloud band, from Babe, which contained gales and moved onshore into the southeastern States. By 1200 on September 5, a surface depression was analyzed just north of Charleston, S.C. (over land). It drifted east-northeastward, slowly becoming organized. By 0000 on the 8th, 200 mi east of Cape Hatteras, Clara reached tropical-storm intensity and became a minimal hurricane 12 hr later with a pressure of 993 mb and 65-kn winds.

Figure 18 shows a satellite picture of Clara with 65-kn winds. Note the low-level cloud circulation is well defined, but there is not much convection near the center.

Winds of 65 kn were maintained in spite of a rising central pressure until early on September 9. The SEALIFT PACIFIC was a little less than 150 mi west of the storm center at 1200 on the 9th and reported 40-kn winds from the north-northwest and 15-ft seas.

Clara made a tight looping motion over a 36-hr period (see fig. 13), and then she accelerated northeastward and was absorbed on the 11th by an extratropical low-pressure system. During the looping Clara briefly threatened Bermuda. There were no damages or casualties.

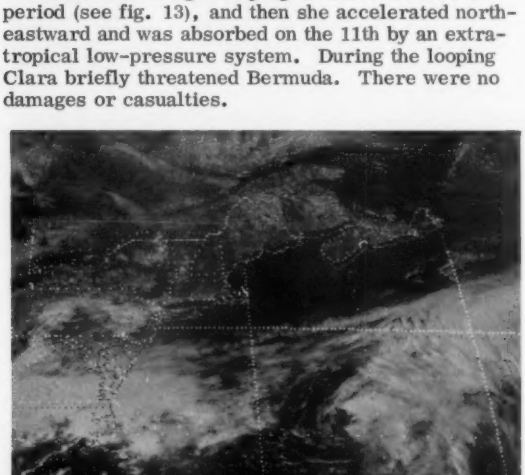

Figure 18.--Clara, a minimal hurricane, about 200 mi north of Bermuda.

HURRICANE DOROTHY, SEPTEMBER 26-30

A tropical wave passed through the northern Windward and southern Leeward Islands of the Caribbean on September 21 with winds gusting to 60 kn and heavy rain. This weather shifted northward, and a tropical depression formed northeast of the Bahamas on the 26th. Moving toward the northeast at 10 to 15 kn, Dorothy reached tropical-storm strength on the morning of the 27th and attained hurricane status on the 28th.

The MARALUNGA crossed Dorothy's path, and the following plain language report was received at the National Hurricane Center:

MARALUNGA ICVC 2 36.8N 57.4W 280900 BAROMETER 1009 WIND FORCE 6 SEA 6 RAIN STOP COURSE 310 TO KEEP AWAY FROM DOROTHY 281300 37.4N 59.2W BAROMETER 1006 WIND FORCE 6/7 NNE SEA 6/7 RAIN COURSE 260 STOP 281600 37.2N 59.7W BAROMETER 1002 WIND 6/7 NNE SEA 6/7 CHANGING COURSE AFTER WEATHER BULLETIN.

Figure 19 shows a satellite picture of Dorothy on the 28th during the time of the above ship report.

The storm lost its tropical characteristics on the 29th, while just east of Cape Race, Newfoundland, and was absorbed by a frontal low-pressure system over the North Atlantic on the 30th. Maximum sustained winds were estimated at 75 kn with a central pressure of 980 mb at 0000 on the 29th.

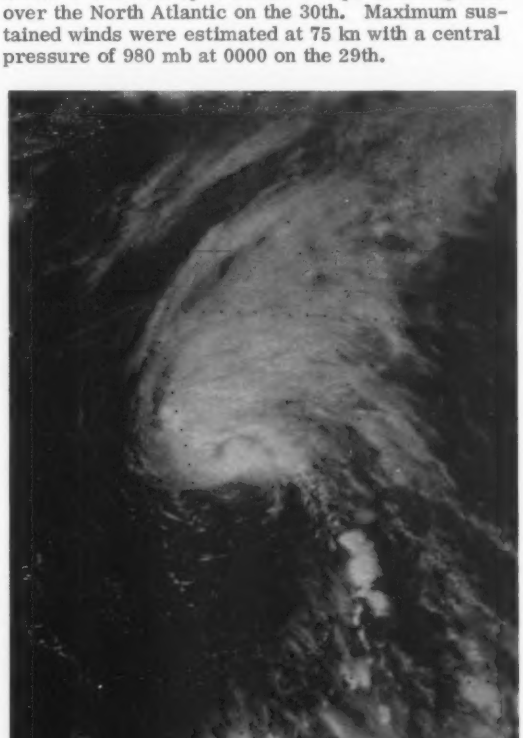

Figure 19.--Hurricane Dorothy on September 28, several hundred miles northeast of Bermuda.

Table 4
NORTH ATLANTIC TROPICAL CYCLONES FOR PAST YEARS

		Frequency of Tropical Cyclones (Including Hurricanes) by Months and Years								Frequency of Tropical Cyclones Reaching Hurricane Intensity by Months and Years								
		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1931			1	1	2	3	1	1		9				2	1	1	1		5
1932		2		3	3	3	1	1		13				2	1	1	1		5
1933		1	1	3	7	5	3	1		21		1	1	2	1	1			6
1934		1	1	1	3	3	2	1		11		1	1	1	1	1	1		6
1935					3	1	2			6				2	1	2			5
1936			2	2	5	4	1			16			1	2	2				5
1937				1	1	6				8					2				2
1938					1	1	3	1		6					1				1
1939			1		1	1	2			5					1	2			3
1940		1			3	2	2			8					1				1
1941						4	2			6					2	1			3
1942					3	3	3	1		10				2			1		4
1943				1	3	4	2			10			1	2	1	1			5
1944				2	3	4	2			11			1	1	2	1			5
1945			1	1	4	3	2			11		1		1	1	1			4
1946			1	1	1	1	2			6			1		1	1			3
1947				1	2	3	3			9					1	1			2
1948		1			3	3	1	1		9				2	1	1	1		5
1949					3	7	3	1		15				1	1	1			3
1950					4	7	2			13				2	4	1			7
1951		1				3	4	2		10	1			2	2	2			6
1952	(Feb.) 1					3	3			7				2	2	2			6
1953		1				3	4		1	11				2	2	1			5
1954			1	1		2	4	1	1	11			1		2	1		1	5
1955				1		4	3	1		13					2	1			3
1956			1	1	1		4	1		9			1	1	2	1			5
1957			2		1		4	1		8			1		2				3
1958			1		6		2	1		10				2	2	1			5
1959		1	2	2	1	2	2			11			1		2	1			4
1960			1	2	1		3			7			1	2					3
1961				1		6	2	2		11				1		1	1		3
1962					2	3	1			6				1	1	2			4
1963			1	1	3	3	1			9			1	1	1	1			4
1964			1	1	4	3	1	1		12				1	1	1			3
1965			1		2	1	1			5				2	1				3
1966			1	4	1	4		1		11			1	2	1	1		1	6
1967					1	5	3			9					1	3			4
1968			2		1	2	1			6			1		1				2
1969				1	1	2	3	1		12				1	1	1	1		4
1970		1		1	1	2				5					1		1		2
1971			1	2	1	3	1	1		11	1			1	1	1			4
1972				2	1	1				4					1				1
1973			1	1	2	2	2			7			1	1	1				3
1974				3	1	3				7					1	1			2
1975			1	1	3	3	1			9				1	2	1			4
1976					1	2	1	1		5					1	1			2
1977				1	3	1	1	1		7					1	1			2
Totals	(Feb.) 1	9	25	57	114	156	93	18	2	441		2	11	19	75	99	44	7	1	258

HURRICANE EVELYN, OCTOBER 13-15

Satellite pictures indicated that a tropical depression had formed 400 mi south of Bermuda on October 13. This depression headed north and passed over Bermuda on the morning of the 14th.

Weather data from Bermuda, as well as ship reports from the STAR ASAHI and CHEVRON MADRID, suggested that Evelyn had reached tropical-storm strength by 0600 on the 14th.

The storm then accelerated north-northeastward and became a hurricane at 0000 on the 15th, based on a reconnaissance report of 994 mb and 72-kn, low-level winds. Figure 20 shows Evelyn about 9 hr prior to reaching hurricane force.

As Evelyn raced toward the Canadian Maritime Provinces, she began to encounter the frontal cloud system also seen in figure 20. The MARINE NAUTICA reported 68-kn winds and 1001 mb just off the southwestern tip of Newfoundland at 1800 on the 15th. Evelyn had been kept at hurricane strength up to this location on the track chart.

The center moved over Cape Breton Island, Nova Scotia, on the 15th. No damages or casualties have been attributed to this storm.

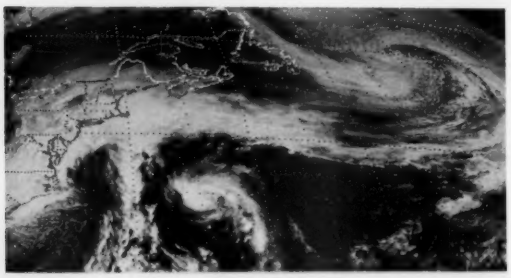

Figure 20.--Evelyn on October 14 prior to reaching hurricane force. An extratropical low with associated frontal cloud bands can be seen west of the storm.

TROPICAL STORM FRIEDA, OCTOBER 16-18

Frieda was a minimal, short-lived tropical storm on the northwestern Caribbean. A series of cold fronts penetrated into the northwestern Caribbean during mid-October, and a tropical wave merged with this frontal cloudiness on the 16th.

Late on the 16th a reconnaissance aircraft found the center of a tropical depression just east of Swan Island. The system moved steadily westward, crossing the coast of Belize on the 18th.

On the 17th 60-kn winds were measured at 1,500 ft, some 50 mi south of the center, and Frieda was upgraded to a tropical storm. Early on the 18th an unidentified ship reported gale-force winds, well southeast of Frieda's center. Figure 21 shows the cloudiness surrounding the poorly defined storm on the 17th.

By landfall, just north of Belize City, maximum winds had decreased to below gale force. Rainfall of 4 to 5 in was measured at Swan Island and Grand Canyon over a period of 1 to 2 days.

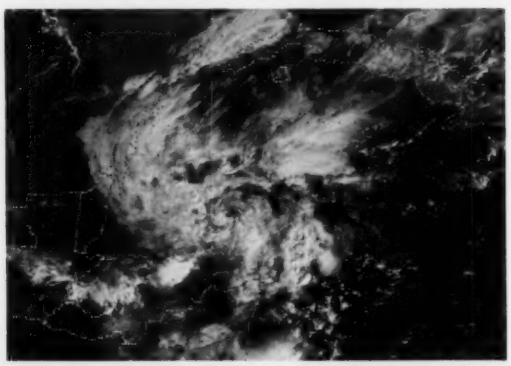

Figure 21.--Cloudiness associated with tropical storm Frieda over the northwestern Caribbean on October 17.

END OF AN ERA

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On September 30, 1977, the U.S. Coast Guard cutter TANEY (fig. 22) departed Ocean Weather Station Hotel enroute to her home port of Portsmouth, Va. This sailing marked the end of a long history of U.S. Coast Guard/National Weather Service cooperation involving the manned U.S. Ocean Stations. The National Weather Service (formerly Weather Bureau) supplied the meteorological personnel and equipment.

The U.S. Ocean Station Program can trace its beginning to pre-World War II. Coast Guard officers Captain G.B. Gelly and Lieutenant D.E. McKay first became interested in the use of Coast Guard cutters to launch weather balloons. A series of experiments was conducted, some from Boston harbor and others from cutters on the International Ice Patrol in the North Atlantic, which showed the value to forecasters

Figure 22.--The U.S. Coast Guard cutter TANEY ended an era as the last cutter to operate on a U.S. Ocean Station. U.S. Coast Guard Photo.

of weather information gathered at sea. Captain Gelly leaked the results of the tests to a friend who had the ear of President Franklin D. Roosevelt. Shortly thereafter, late in 1939, Admiral Russel R. Waesche, Commandant of the Coast Guard, received instructions to set up a weather observation service in the North Atlantic. Surface weather reports normally transmitted by shipping ceased in 1939 with the war in Europe because of requirements for radio silence by the belligerent nations and withdrawal of U.S. shipping in the European trade.

Initially there were only two stations, one at 35.6°N, 53.3°W, and the other at 37.7°N, 41.2°W, each to be manned by a new, high-endurance-class cutter. Planners originally had worked out 3-week cruises within a 100-mi radius of a central point or station, but this was later revised to an area 210 mi square, divided into subareas 10 mi to a side. The cutters, in addition to providing weather for forecasting, also gave valuable enroute weather information and navigational fixes for new transoceanic flights. The first cutters, BIBB and DUANE, arrived on station on February 10, 1940, with weathermen and meteorological equipment aboard (fig. 23). Surface and upper air meteorological observations were recorded and transmitted along with sea conditions and other oceanographic parameters. Launching of the upper air sounding balloons (fig. 24) was difficult and dangerous during high winds and rough seas.

Figure 24.--Launching weather balloons was hazardous during high winds and seas.

Figure 23.--The U.S. Coast Guard cutter BIBB, one of the first cutters to man Ocean Stations, as she appears today. U.S. Coast Guard Photo.

As war clouds gathered over Europe, air traffic increased with large numbers of combat and cargo aircraft attempting to bring help to an embattled Britain. By December 7, 1941, a third station was functioning; and when the war in Europe ended, 16 stations were operating in the North Atlantic. The total number of stations, including special stations for the Normandy invasion and those operated by other countries, reached a high of 22 during the war.

Ocean Stations in the Pacific expanded as rapidly as did those in the Atlantic. By the end of the war there were 24 stations operating.

In 1946 the United States joined the International Civil Aviation Organization and worked for the continuation of the Ocean Stations in peacetime. One of the purposes of the Ocean Stations was to provide a search-and-rescue capability over the long stretches of ocean. Seven years after steaming out to the first station, the cutter BIBB proved the wisdom of this planning.

On October 13, 1946, a large four-engine Boeing 314 Clipper took off from Ireland bound for Gander, Newfoundland, on a charter flight. Captain Martin, at the controls of the BERMUDA SKY QUEEN, had 62 passengers and a crew of 7 under his care. The lumbering aircraft encountered high headwinds. By the time the BERMUDA SKY QUEEN reached the Ocean Station that the cutter BIBB was manning--halfway between Labrador and Ireland--Captain Martin had passed the point of no return. To this was added the navigator's report that there was not enough fuel to make Gander.

Martin radioed the BIBB, which was fighting 30-ft waves. Captain Paul B. Cronk, Commanding Officer of the BIBB, ordered ditch and rescue stations set. Soon the crew was at their stations awaiting the BERMUDA SKY QUEEN. In a masterful show of airmanship, Martin ditched the big Boeing perfectly, and the plane's big triple rudders kept her from broaching (fig. 25).

Captain Cronk now had to somehow get the 69 passengers and crew out of the aircraft, through the 30-ft seas, and to safety aboard the BIBB. He first attempted to do this by lowering a pulling boat with a rubber raft in tow. As the boat approached the bobbing plane, the rubber raft was allowed to drift close

Figure 25.--The BERMUDA SKY QUEEN ditched near the cutter BIBB. Pulling boat from the BIBB setting out to reach the QUEEN. U.S. Coast Guard Photo.

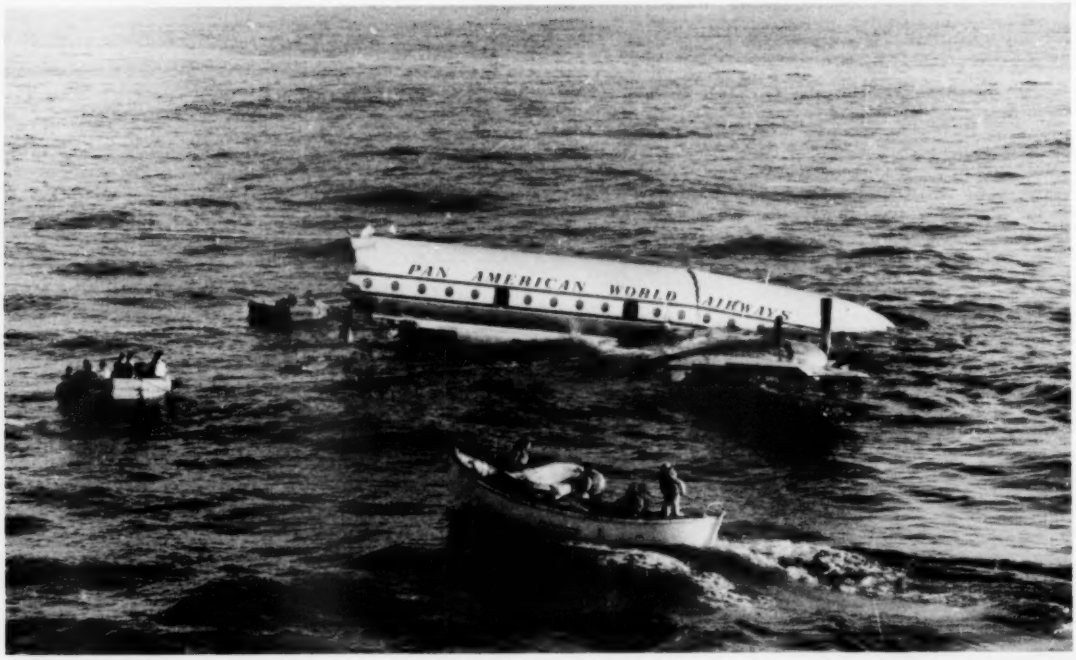


Figure 26.--A lifeboat from the cutter PONTCHARTRAIN speeds to the aid of survivors of the broken, sinking SOVEREIGN OF THE SKIES moments after it ditched. U.S. Coast Guard Photo.

to the aircraft, and the passengers would then leap into the raft and would be hauled to the pulling boat.

After many problems and just as darkness was falling, the first 16 passengers exited the plane. It became evident to Captain Cronk that if he attempted to retrieve everyone in the darkness and the heavy seas continued, there was a chance of injury. A decision was made to halt operations until daylight, unless the aircraft began to show signs of breaking up.

Morning brought subsiding seas, and rescue operations began again. At 0833 on October 15, 25 hr after the BERMUDA SKY QUEEN ditched, all passengers were safely aboard the BIBB--not a single life was lost.

Nine years later on October 19, 1956, a similar drama was played out on Ocean Station November about halfway between Honolulu and San Francisco. On this fateful day a Pan American Clipper, the SOVEREIGN OF THE SKIES, ditched alongside the cutter PONCHARTRAIN. The aircraft broke in half, but fast work by the clipper's crew got all of the passengers into rubber rafts (fig. 26). Almost as soon as the plane hit the water, PONCHARTRAIN's small boats were churning toward the sinking aircraft. Once again, because a Coast Guard cutter was on Ocean Station duty, everyone aboard lived to tell the tale.

Such rescues highlighted one of the important jobs of the Ocean Stations and lent an air of excitement to the duty. The duty for the most part, however, was far from glamorous. Weather was rarely calm, and about the only diversions for the crew were movies, volleyball games when the weather permitted, reading, and card games.

As years passed stations were added, dropped, or changed as technology requirements and funding dictated. By late 1950 and into the 60's the Coast Guard manned four stations in the Atlantic and two in the Pacific. Interestingly, it was changing technology that brought about the demise of the stations. Weather and communication satellites offered a means to obtain data at reduced effort. Aircraft also changed. When Ocean Stations first started, piston-driven aircraft flew at low altitudes and, thus, were affected by weather. However, by the late 60's high-flying, fast jet aircraft were capable of long ranges and were not greatly affected by weather. In other words, at the higher altitudes the more reliable aircraft ceased to need the services of the floating stations. By the end of June 1974 the Coast Guard had stopped all of its former stations except one, Ocean Weather Station Hotel.

Ocean Weather Station Hotel was the youngest of the floating weather stations. Its original location about 200 mi east of the Maryland-Virginia coast was reestablished in 1970 as part of a supplemental weather program for the tracking and improved forecasting of East Coast storms and hurricanes. The station was manned from August 1 through April 15 each year. The European community still operates four stations

in the North Atlantic, and Canada and Japan each have one station in the North Pacific.

Funds for the operation of Coast Guard cutters on Ocean Weather Station Hotel were deleted from the Fiscal Year 1978 budget. To compensate for the loss of manned station weather data, NOAA will now use increased aerial weather reconnaissance, meteorological satellites, and new deep-ocean environmental buoys.

In addition to the operational value of the observations to the weather analyst and forecaster, these relatively fixed stations provided measured long-term point data for use in many climatological atlases and statistical studies, such as the extremes, persistence and variability of winds in both speed and direction, height of waves, visibility, sea and air temperatures, and so forth, with their daily and seasonal fluctuations. The stationary buoys will continue to provide this same type of long-time point data base. The Mariners Weather Log has published climatological summaries and gale observations of Ocean Weather Station data since 1957. Ocean buoy summaries were added in 1975, and with this issue buoy data will be added to the "Selected Gale and Wave Observations."

The U.S. Coast Guard cutter ACUSHNET deployed EB-07 (now 44007) at 39°N, 70°W, on September 21, 1977, to assume part of the new meteorological data collection duties (fig. 27). This discus-shaped buoy (40 ft diameter) will record and transmit surface weather data automatically and is designed to remain on station for 3 yr. EB-07 is 1 of 10 environmental buoys in the North Atlantic. Five of these are north of Cape Hatteras. Coast Guard cutters will provide continuing support of these environmental buoys in accordance with an interagency agreement with NOAA.

With the departure of the cutter TANEY, a history of manned Ocean Weather Stations that stretched over a 37-yr period came to an end, thus bringing to a close another era of Coast Guard and Weather Service history.

Figure 27.--EB-07 is the new platform that will collect meteorological data near the old station Hotel.

AN INTENSE OCTOBER NORTHEAST PACIFIC STORM

H. Clayton Creech
School of Oceanography
Oregon State University
Newport, Ore.

Two intense storm systems moved into the Gulf of Alaska during the last 10 days of October 1977 and produced extremely high waves on the Pacific Northwest coast which caused coastal erosion, damage to several motels, and the loss of one life. Significant swell heights of 19 ft (~33 ft max.) with a 17-s period were measured with Oregon State University's wavemeter system (Quinn et al., 1974; Zopf et. al., 1976) at the entrance to Yaquina Bay on the central Oregon coast.

A storm with a central pressure of 976 mb moved across the northeastern Pacific and deepened to 944 mb by 0000 on October 24 at 46°N, 146°W. Ships reported 70-kn winds and 30-ft swells in its southern sector. Winds in the southern sector decreased to 30 kn by 0000 on October 26. Then another intense system with a central pressure of 938 mb at 1200 on October 25 moved across the northeastern Pacific over the next 4 days. The southern and southwestern sectors of such lows are the principal generating areas for swells that eventually reach the Oregon coast.

A careful study of the 6-hourly National Meteorological Center surface charts (fig. 28 is an example)

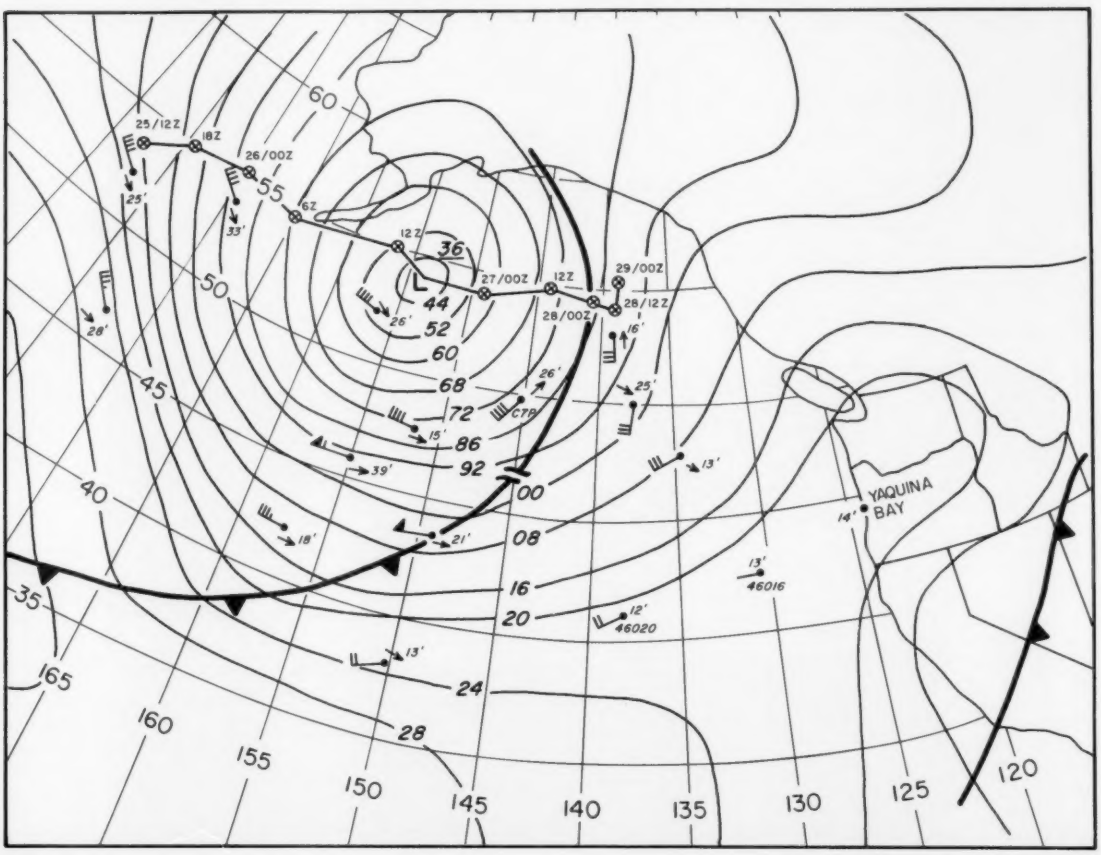


Figure 28. -- NMC final surface analysis for 1800 October 26, 1977, with ship-reported winds; swell heights and directions are also included. Wave height at the entrance to Yaquina Bay, Ore., is indicated. Locations of storm centers are indicated and labeled with time.

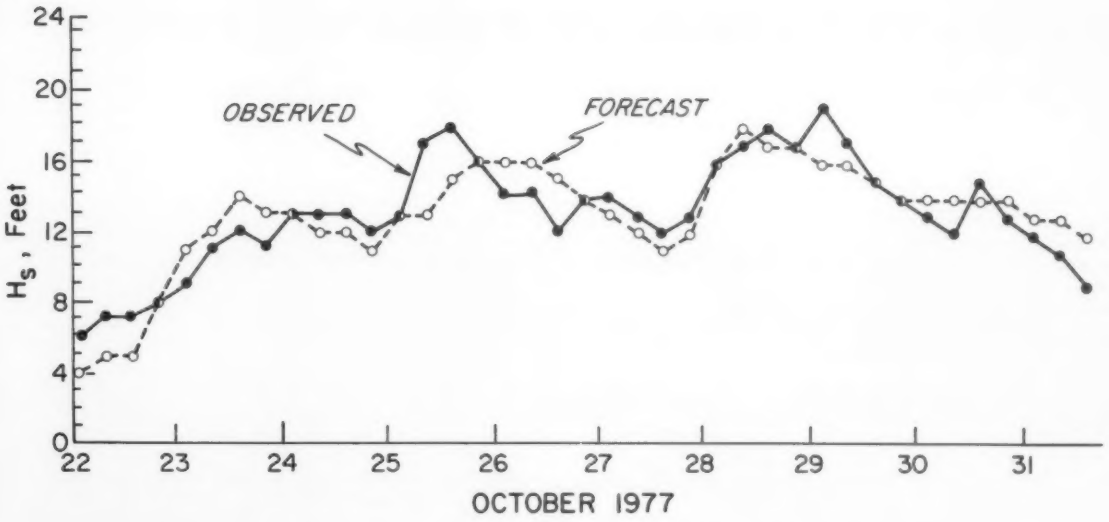


Figure 29.--Comparison of observed significant wave height, H_S, at Yaquina Bay entrance with hindcast results obtained from semiautomated wave forecasting system.

revealed 10 fetches with sustained winds of 25 kn or greater in the northeastern Pacific between October 18 and 30. Durations and windspeeds in the fetches varied from 42 hr at 25 kn to 30 hr at 52 kn. Fetch lengths varied from 400 to 600 mi. Hindcast results using Oregon State University's semiautomated wave forecasting system (Oregon State University, 1973) are shown in figure 29. The hindcast wave heights compare favorably with observed heights.

High waves on October 25 crashed through windows of the lounge at a beach front motel in Depoe Bay, about 15 mi north of Yaquina Bay, and waves on October 28 completely destroyed the interior of the structure (fig. 30). Other motels in the Lincoln City area sustained major damage to their first floor rooms, and a woman standing on the steps of one motel was washed to sea and drowned.

On October 27 the National Weather Service Forecast Office in Portland, Ore., posted gale warnings along the entire coast of Oregon and predicted swells along the coast increasing to 15 to 20 ft later that night and the next day, based on real-time guidance received from the semiautomated forecast system and ship and buoy reports. Storm surge at South Beach (Newport) caused tide gage readings to be 1.5 ft above expected levels during the early morning of the 28th, when the measured high-tide level was 9.2 ft above the mean lower low-water level.

On the afternoon of October 28 the Oregon State University Research Vessel WECOMA attempted to enter her home port of Yaquina Bay. While approaching the entrance buoy (moored at a depth of 100 ft) the chart speed on the ship's Ross fathometer was

Figure 30.--Wave damage to Surfpoint Inn lounge at Depoe Bay on October 28 is estimated at $30,000. Lounge is about 25 ft above sea level. Newport News-Times Photo.

increased to about 1/4 in/min. The captain recorded occasional waves 36 ft high at this time on the fathometer trace. The R/V WACOMA attempted another entry on the morning of the 29th but remained bar bound until late that day. An indication of the rough bar conditions at the harbor entrance is shown in figure 31.

These two instances where significant wave heights of 18 ft or greater occurred during October are highly unusual. It is the first time in the past 6 yr of observations near the entrance to Yaquina Bay that waves higher than 14 ft have occurred in October. Normally, the highest waves occur between November and March (Creech, 1977).

Editor's Note: See "Gale and Wave Tables" for a listing of the many ships reporting high winds and waves. In the Remarks column of the 0600 October 25 observation, the OVERSEAS CHICAGO reported "occasional swell to 80 ft." See Smooth Log starting on page 113.

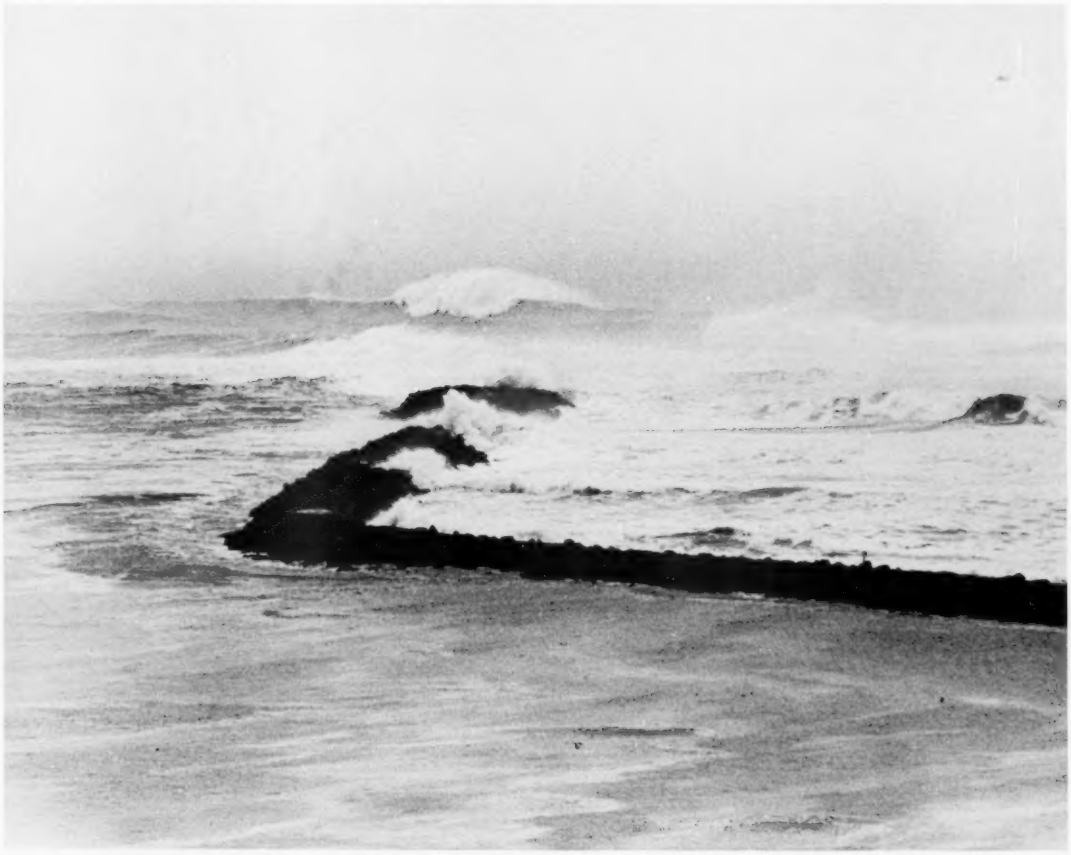


Figure 31. -- Estimated 35-ft breaking wave at entrance to Yaquina Bay on October 29, 1977. Newport News-Times Photo.

ACKNOWLEDGMENTS

We acknowledge the contributions of Captain Howard Linse of the R/V WACOMA and the National Weather Service (Western Region) to this work, which is sponsored by the NOAA Sea Grant Program under Contract 04-6-158-44094 with Oregon State University.

REFERENCES

Creech, H.C., 1977: "Five year climatology (1972-1976) of nearshore ocean waves off Yaquina Bay, Oregon." Oregon State University Sea Grant College Program, Ref. ORESU-T-77-011, 17 pp.

Quinn, W.H., H.C. Creech, and D.O. Zopf, 1974: "Coastal wave observations via seismometer." Mariners Weather Log 18(6): 367-369.

Oregon State University, 1973: Operations Manual: Semi-automated wave forecasting system. School of Oceanography, Oregon State University, 94 pp.

Zopf, D.O., H.C. Creech, and W.H. Quinn, 1976: "The wavemeter: A land-based system for measuring nearshore ocean waves." Marine Technology Soc. Journal 10(4): 19-25.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Hints to the Observer

DIURNAL PRESSURE VARIATION AND TROPICAL CYCLONE DEVELOPMENT

Similar to ocean tides, atmospheric pressure rises and falls twice a day. This pressure "tide" is called diurnal pressure variation. During each 24-hr period two highs occur, one at approximately 1000 and the other at 2200, local time. The two lows occur at approximately 0400 and 1600, local time. The range of the diurnal pressure change is greatest in tropical areas and becomes smaller toward the middle and higher latitudes. In the middle and higher latitudes, the movement of storm centers during much of the year causes such large changes in pressure that the normal diurnal variation is masked. In tropical waters, however, the barograph trace will usually show the familiar sine curve, with two crests and two troughs during a 24-hr period, as illustrated in the barogram (fig. 32).

In the Tropics, changes from the normal diurnal pressure pattern may indicate formation of a tropical cyclone. The usual signs are that the minimum trough of the barograph trace or other pressure record is much deeper, or that the maximum fails to develop. By use of the barograph and reference to one of the marine atlases it is possible to tell whether or not the change from the normal diurnal value is significant. Under normal conditions the diurnal variation should oscillate about the mean pressure value. Whenever the diurnal value drops 3 to 5 mb below the mean pressure during the hurricane season, a tropical cyclone is probably developing in the area. Figure 32 shows a normal range of diurnal pressure variation for tropical latitudes. Note the drop in pressure prior to the normal crest of the diurnal high and the sharper than normal drop in pressure as the PRESIDENT MADISON approached tropical storm Agatha. Other significant weather parameters should be observed, depending on the location of the ship, such as a change in the wind direction to a westerly component or higher than the normal windspeeds; an increase in shower activity which tends to persist; and an increased swell pattern or a swell pattern moving from an unusual direction for the particular waters.

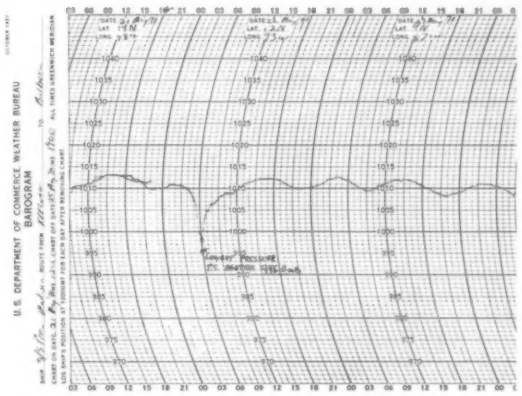


Figure 32.--Barogram of the PRESIDENT MADISON showing normal diurnal pressure variations and pressure drop when Agatha was encountered.

Tips to the Radio Officer

WMO SHIP-TO-SHORE TELECOMMUNICATIONS SURVEY

In mid-1977 the World Meteorological Organization distributed a questionnaire to ships in the Voluntary Observing Ship Program to determine what difficulties they had encountered and what suggestions they could make to improve ship-to-shore telecommunications. Below is a summary of the replies to the questionnaire which was compiled by William G. Dillion of the National Weather Service.

Out of 535 mailings to selected ships, 126 questionnaires were returned, or almost one in four (1 in 10 is considered good for most surveys). Of the 126 that were returned, 101 had comments or suggestions for improvement of the existing ship-to-shore communications system.

The most bothersome difficulties were radio interference and poor shore radio station procedures (fig. 33 a). Interference included both atmospheric interference and interference from overworked frequencies, made worse by requiring weather observations to be transmitted at or soon after the synoptic hours of 00, 06, 12, and 18. There was also an interference problem encountered by some ships in the North Pacific from a station transmitting on the same frequency as U.S. Coast Guard Station Adak (NOX), Alaska. The complaints about shore stations were: (1) they were undermanned; (2) operators were sometimes slow, inexperienced, and kept poor radio watches; and (3) there were frequently long waiting periods before messages were accepted. It should be noted that there were nearly as many compliments as complaints about shore station procedures (30 to 33, respectively.

Figure 34 b is a graph of the suggested improvements. They are: (1) establish times for shore stations to accept only weather observations; (2) improve the skill of shore-station operators; and (3) stagger

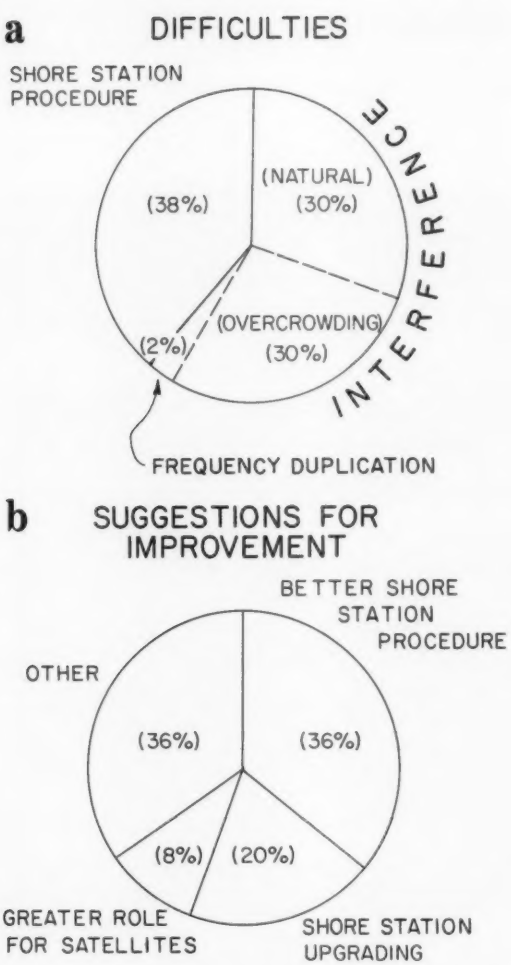


Figure 33.--Pie charts showing results of WMO survey of U.S. ships regarding radio communications of meteorological observations.

transmissions to approximate radio officer watch hours. Suggestions for shore-station upgrading included: (1) increase the power and sensitivity of shore-station transmitters and receivers; (2) improve frequency scanning; and (3) increase manpower. One way suggested to avoid interference and crowding was to send weather observations via satellite.

Other comments that did not fall into the above categories included the need to replace antiquated ship radio equipment and radio coverage problems in not being able to raise shore stations from particular geographical areas.

CORRECTIONS TO WORLDWIDE MARINE WEATHER BROADCASTS (July 1977 Edition)

All times are GMT, and frequencies are kHz unless otherwise indicated.

Page 4 Add to Table of Contents:
0850 Ketchikan, Alaska (NMJ)
1545 Mauritus (3BM)

Page 18
1-0770
PT. REYES, CALIF. (NMC)

0630	4346, 8682, 12730	W,S,P[2]
0030, 1900, 2100	8682, 12730, 17151.2	W,S,P[2]
0330, 1700	420	W,S,P[3]

1-0780
SAN FRANCISCO, CALIF. (KPS)
Delete frequency 8713.5; insert 6348, 8445

1-0850 New Station
KETCHIKAN, ALASKA (NMJ)
Area:

0530, 1730	416	W,F

1-0880
VANCOUVER, B.C. CANADA (VAI)
Delete times 0530, 1730; insert 0930, 1330

Page 19
1-0945
GUAM, MARIANAS IS. (NRV)
Delete time 0000, insert 0100

Page 22
1-1200
TAIPEI, TAIWAN (BMB)
Add frequency 3641

1-1210
KAO-HSIUNG, TAIWAN (XSW)
Add times 0500, 1700

1-1220
KEELUNG, TAIWAN (XSX)
Add times 0430, 1630
Delete frequency 8714; insert 8445, 12695

Page 27
1-1570
DJIBOUTI, AFARS AND ISSA
Change call sign to (J2A)

1-1650
BOMBAY, INDIA (VMB)

0618, 1518	518, 8514	SR[2], LR[3]
0848, 1648	518, 8514	W,S,P[4], A[5]
0820, 1620	518	W,S,P[6]

Page 28
1-1670
MADRAS, INDIA (VWM)

0930, 1830	515, 8674	W,S,P[2]
0950, 1850 0450[3], 1350[3] 2150[3]	515	W,S,P[4]

1-1680
CALCUTTA, INDIA (VWC)

0848	470, 12745	SR[2], LR[3]
0950, 1850	470, 12745	W,S,P[5], A[6]
1418	470, 8526	SR[2], LR[3]
1818, 0918	470, 4286, 12745	W,S,P[5], A[6]
0018, 0418 1318, 2118	500	W[7]
0018	500	W,S,P[8]

1-1690
KANDLA, INDIA (VWK)

0820, 1620 0420[2], 1220[2], 2020[2]	440	S,F

1-1700
RATNAGIRI, INDIA (VWZ)

0820, 1620 0420[2], 1220[2], 2020[2]	420.5	S,F

1-1710
GOA, INDIA (VWG)

0820, 1620 0420[2], 1220[2], 2020[2]	417.5	S,F

1-1720
MANGALORE, INDIA (VWL)

0820, 1620 0420[2], 1220[2], 2020[2]	438	S,F

Page 28

1-1730
COCHIN, INDIA (VWN)

0820, 1620	460	S,F
0420[2], 1220[2], 2020[2]		

1-1740
TUTICORIN, INDIA (VWT)

0950, 1850	487	S,F
0450[2], 1350[2], 2150[2]		

Page 29

1-1750
VISHAKHAPATNAM, INDIA (VWV)

0950, 1850	474	S,F
0450[2], 1350[2], 2150[2]		

1-1760
PORT BLAIR, INDIA (VWP)

0950, 1850	442	S,F
0450[2], 1350[2], 2150[2]		

Page 31

Add to Table of Contents:
0282 Chincoteague, Va. (NMN70)
0286 Hampton Roads, Va. (NMN80)
0315 Cape Hatteras, N.C. (NMN13)

Page 32

1232 Valdez, Alaska (NMJ3)
Delete Station 1260 Juneau, Alaska

Page 34

2-0031
PORTSMOUTH, VA (NMN)
Area (a) High Seas: North Atlantic north of 03°N, of 35°W.
(d) Offshore Waters: Southwest North Atlantic, Gulf of Mexico and Caribbean Sea.

0400	4428.7 6506.4 8765.4	W,S,F[2]
0530	do.	W,S,F[3]
1000	do.	W,S,F[4]
1130, 2330	6506.4 8765.4 13113.2	W,S,F[3]
1600, 2200	do.	G,W,S,F[5]
1730	8765.4 13113.2 17307.3	W,S,F[3]

2-0040
FROBISHER BAY, N.W.T., CANADA (VFF)
Delete frequency 4409.4, insert 4376.0

Page 35

2-0160
GRANDSTONE, MAGDALEN IS., CANADA (VCN)
Delete time 1735, insert 1820

2-0190
QUEBEC, QUEBEC, CANADA (VCC)
Add frequency 161.65 MHz

Page 36

2-0210
HALIFAX, N.S., CANADA (VCS)

0303, 0745, 1550 2110	2598, 161.65 MHz	W,S,F
0805, 1605, 2205, 0205	4410.1	W,S,F
0815, 1615, 2215, 0215	8787.1	W,S,F
1625, 2225	13138.0	W,S,F

Page 37

2-0280
BALTIMORE, MD (NMX)
Delete frequency 2670, insert 157.1 MHz

2-0282 New Station
CHINCOTEAGUE, VA (NMN70)
Coastal waters area 5 figure 3

0233, 1403	2670	W,S,F

2-0286 New Station
HAMPTON ROADS, VA. (NMN80)
Coastal waters area 5 figure 3

0203, 1333	2670	W,S,F

2-0315 New Station
CAPE HATTERAS, N.C. (NMN13)
Coastal waters area 6 figure 3

0133, 1303	2670	W,S,F

2-0330
CHARLESTON, S.C. (NMB)
Delete "Cape Fear, N.C.," insert "Little River Inlet."

2-0340
CHARLESTON, S.C. (WJD)
Delete "Cape Fear, N.C.," insert "Little River Inlet."

Page 38

2-0390
MIAMI, FLORIDA (WDR)
Delete "Ponce de Leon," insert "St. Augustine."

Page 46

2-1160
SAN FRANCISCO, CALIF. (NMC)

0430, 1030, 1230	4428.7, 8765.4, 13113.2	W,S,F
1630, 2230	8765.4, 13113.2, 17307.3	W,S,F
1530, 2330	157.1 MHz	P[2]
0203, 1403	2670	P[2]

Page 47

2-1232 New Station
VALDEZ, ALASKA (NMJ3)
Coastal waters area 2 figure 10

233, 0833, 1433, 2233	2670	W,S,F
0015, 1215, 1615, 2015	157.1 MHz	W,S,F

2-1230
KODIAK, ALASKA (NOJ)

0203, 1645	2670, 6521.8	W,S,F
0030, 0230, 0530, 1330, 1800	157.1 MHz	W,S,F

2-1250
OCEAN CAPE, ALASKA (NMJ-19)

0145, 0845, 1345,	2670	W,S,F
2045, 0203, 1403	157.1 MHz	W,S,F

2-1260
JUNEAU, ALASKA (KCI97)
Delete station

2-1261
JUNEAU, ALASKA (NMJ1)

0303, 1503	2670	
0103, 0203, 0303, 1303, 1403, 1503	157.1 MHz	

2-1270
BIORKA, ISLAND, ALASKA (NMJ18)

0803, 1250, 2003,	2670	
2330	157.1 MHz	

Page 48

2-1280
KETCHIKAN, ALASKA (NMJ)

0315, 1515	2670	
0115, 0215, 031[5]	157.1 MHz	
1315, 1415, 1515		

Page 48

2-1370
VANCOUVER, B.C., CANADA (VAI)

2115, 0010, 0310	1630	

Delete frequency 161.9 MHz

Page 49

2-1470
HUMBOLDT BAY, CALIF. (NMC11)

0333, 1503	2670	W
1545, 2315	157.1 MHz	W,S,F

Page 50

2-1530
HONOLULU, HAWAII (NMO)

0303, 0903, 1503, 2103	2670	W,S,F[1]
0545, 1745	6506.4[2] 8765.4 13113.2[6]	W,S,F[3]
	157.1 MHz	W

Page 52

2-1690
PORT MORESBY, PAPUA (VIG)
Add:

On request	6515.7	W

2-1700
RABAUL, NEW BRITAIN (VJZ)

0503, 2103	2201	W,S,F
0233, 2348	4407	W,S,F
On request	6515.7	W

Page 59

3-0180
DAKAR, SENEGAL (6VU/6VY)
Delete times 0950, 2150
Insert:

0400, 1000, 1600, 2200	Surface analysis
1015, 2215	24-hr surface prognosis
0340, 0940, 1140, 1540, 2340	Test chart

Page 63

3-0320
SAN FRANCISCO, CALIF. (NMC)
Amend footnote [2] - Used for 1820, 2000, and 2300 transmissions only.

Page 64

3-0380
TOKYO, JAPAN (JMH)
Delete time 2000, insert 2200

Page 66 3-0440
CANBERRA, AUSTRALIA (AXM)

1025, 2225	Surface analysis - Southern Hemisphere
0645, 1135, 1735, 2335	Surface analysis - East Pacific Equatorial
0745, 1845	Surface analysis - Indian Ocean
0135, 0835, 1345, 2045	Surface analysis - Western Indian Ocean, Southern Pacific

Page 69 Delete New York, N.Y. (WSY70)

Page 77 Add to list of NOAA Weather Radio Stations.

Cordova, Alaska	WXJ-79	162.55
Fairbanks, Alaska	WXJ-81	162.55
Sitka, Alaska	WXJ-62	162.55
Valdez, Alaska	WXJ-63	162.55
Melbourne, Fla.	WXJ-70	162.55
Gainsville, Fla.	WXJ-60	162.475
Orlando, Fla.	KIH-63	162.475
Meriden, Conn.	WXJ-42	162.40
Santa Barbara, Calif.	KIH-34	162.40
Philadelphia, Pa.	KIH-28	162.475

Several vessels have reported that station J2A, Djibouti, no longer accepts ships' weather messages.

ACKNOWLEDGMENTS

Thanks to O.J. Toland, SS JEFF DAVIS; J.H. van der Leest, SS ESSO BONAIRE; and Robin E. Lagemann for information relative to the Marine Weather Program.

Hurricane Alley

Dick DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

SOUTH PACIFIC
NOVEMBER AND DECEMBER 1977

November and December mark the beginning of the tropical-cyclone season in the South Pacific seas. This season four tropical storms spread their gales from the Solomon Islands to the Tuamotus (fig. 34). Tom and Steve came to life in November. Tom roamed through the Solomons early in the month and peaked at about 40 to 45 kn on the 8th and 9th. By the 12th, however, all that was left was a weak low-level circulation. Steve developed a few weeks later and packed a little more punch as he moved southward between the New Hebrides and Fiji Islands. On the 26th (fig. 35) and 27th winds near Steve's center were whipping around at 60 kn with gusts of hurricane force. By the 28th the storm began to weaken, and the remnants were no longer visible on the 30th.

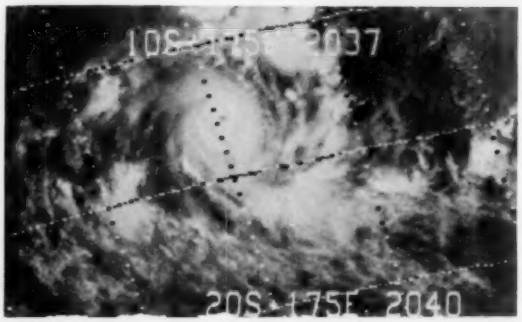


Figure 35.--Steve flexes his 60-kn muscles on the 26th.

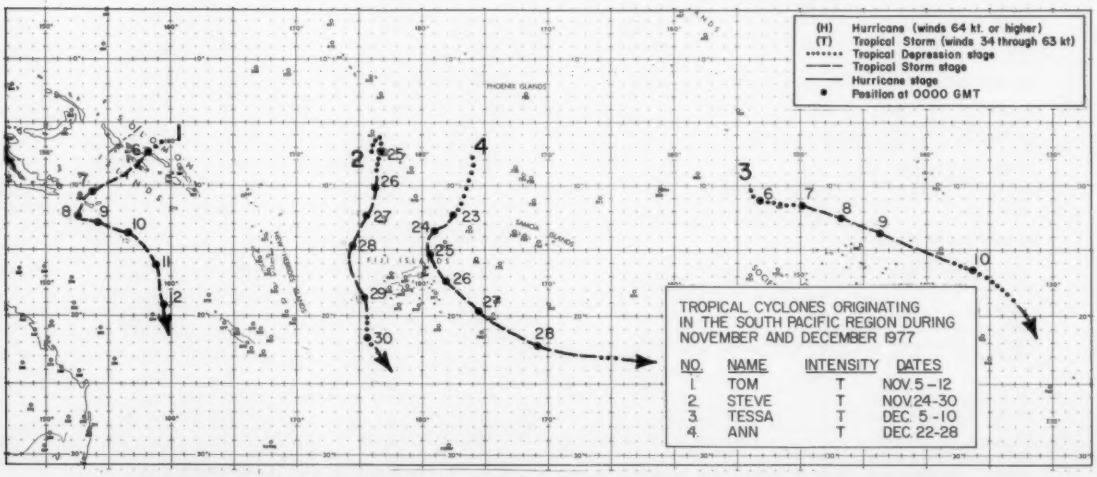

(H) Hurricane (winds 64 kt. or higher)
(T) Tropical Storm (winds 34 through 63 kt)
Tropical Depression stage
Tropical Storm stage
Hurricane stage
Position at 0000 GMT
TROPICAL CYCLONES ORIGINATING IN THE SOUTH PACIFIC REGION DURING NOVEMBER AND DECEMBER 1977
NO. NAME INTENSITY DATES
1. TOM T NOV. 5-12
2. STEVE T NOV. 24-30
3. TESSA T DEC. 5-10
4. ANN T DEC. 22-28

Figure 34.--South Pacific tropical cyclone tracks, November and December 1977.

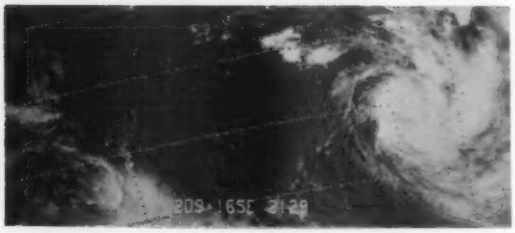


Figure 36.--Ann sprawls across the tropical Pacific during her formative stages on the 24th.

Tessa and Ann were December's South Pacific beauties. Tessa began to blossom north of the Society Islands. She headed southeastward, coming into flower on the 7th and 8th when winds were estimated at 35 kn--just minimal tropical-storm strength. Tessa remained in bloom for another few days before fading in eastern waters. Ann was by far the better developed of the two (fig. 36). Her winds very nearly reached hurricane strength on the 26th as she brushed the Fiji Islands. By this time she was heading southeastward into the open Pacific.

SOUTH INDIAN OCEAN
NOVEMBER AND DECEMBER 1977

Hurricane Aurore and tropical storm Sam roamed the South Indian Ocean waters east of Diego Garcia during this 2-mo period. Aurore developed in November and moved on a southerly course. Her winds were estimated at hurricane force from early on the 21st through the 23d. At her peak late on the 21st (fig. 37) and

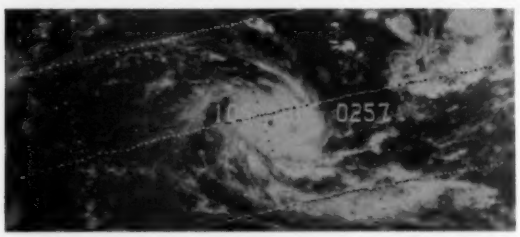


Figure 37.--Aurore exposes a tight circulation of hurricane intensity on the 21st.

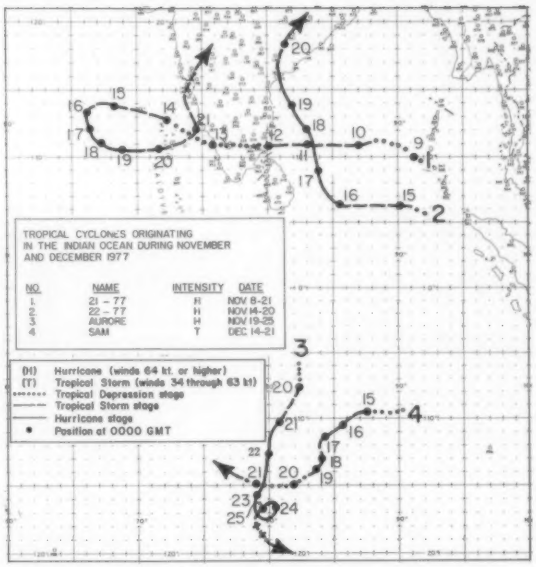

TROPICAL CYCLONES ORIGINATING IN THE INDIAN OCEAN DURING NOVEMBER AND DECEMBER 1977
NO. NAME INTENSITY DATE
1 21 - 77 H NOV 8-21
2 22 - 77 H NOV 14-20
3 AURORE H NOV 19-25
4 SAM T DEC 14-21
(H) Hurricane (winds 64 kt. or higher)
(T) Tropical Storm (winds 34 through 63 kt)
Tropical Depression stage
Tropical Storm stage
Hurricane stage
Position at 0000 GMT

Figure 38.--Indian Ocean tropical cyclone tracks, November and December 1977.

on the 22d, 85-kn winds roared around her center. Gales extended out to 180 mi in all directions. On the 24th Aurore slowed, turned, and lost intensity. By the 25th only a weak circulation remained.

Sam was first detected on the 14th. Tracking westward then southward, he reached tropical-storm strength the next day and reached a peak by the 17th. On the 17th and 18th 40-kn winds blew around his center. Sam swung westward but began to weaken. By the 21st only a weak low-level circulation remained.

NORTH INDIAN OCEAN
NOVEMBER AND DECEMBER 1977

The two tropical cyclones that formed in November (fig. 38) were the only two during this 2-mo period. These hurricanes were described in the last issue of the Log. More details will be published when we receive information from the Indian Meteorological Service.

On the Editor's Desk

GULF STREAM BROADCAST FREQUENCIES

In the article, "Utilization of Offshore Currents for Improved Ship Efficiency," in the January 1978 issue of Mariners Weather Log, the frequencies listed for Radiotelephone Portsmouth, Va. (NMN) were incorrect. The correct frequencies in kHz are: 6506.4, 8765.4, and 13113.2.

STORM, FLOOD EVACUATION MAPS READY

The publication of six storm evacuation maps along the Atlantic Coast from Jacksonville, Fla., to Savannah, Ga., has been announced by NOAA's National Ocean Survey.

The maps show emergency evacuation routes, areas subject to flooding from hurricanes and other storms, and elevations which might afford "safe islands" for storm evacuees. The six maps include Jacksonville Beach, Jacksonville, and Fernandina Beach in Florida; St. Marys, Kingsland, Woodbine, Brunswick, St. Simons Island, Darien, Ludowici, and Riceboro in Georgia. The counties are Duval and Nassau in Florida; Camden, Glynn, Wayne, McIntosh, Long, and Liberty in Georgia.

Figure 39.--The POLAR STAR on a shakedown cruise in Puget Sound. U.S. Coast Guard Photo.

The storm evacuation maps include a delineation of areas subject to flooding by surges of various heights; main evacuation roads and feeder roads; low points along the roads that might be engulfed; and high spots which are likely to remain unaffected by flood waters.

To date, 71 maps have been issued for seven Gulf Coast areas and a number of Atlantic Coast regions.

BREAKING THE ICE

The world's largest and most powerful icebreaker, POLAR STAR, made its debut over the Christmas weekend in McMurdo Channel in Antarctica, according to a spokesman for the U.S. Coast Guard. He said the ship, held in drydock for a year because of mechanical problems, had no problems on its first icebreaking assignment. The ship used her diesel engines and gas turbines to ram through 3 to 8 ft of ice.

The POLAR STAR was scheduled on December 30, 1977, to begin forging a path to McMurdo Station west of the Ross Ice Shelf, the largest solid ice shelf in Antarctica.

The POLAR STAR (fig. 39) is 13,000 tons and 120 m in length.

NOAA PUBLISHES NEW MAP AND CHART CATALOG

A new catalog of special purpose charts and bathymetric maps has been published by NOAA's National Ocean Survey. This five-color map and chart catalog indexes bathymetric maps, topographic/bathymetric maps, and marine boundary maps and charts.

Also indexed for the first time are Tidal Current Charts, Marine Weather Service Charts, Storm Evacuation Maps, and orthophoto maps of Florida's coastal zone. Included are insets indexing Offshore Mineral Leasing Area Maps, Geophysical Maps, and the International Hydrographic Bureau (IHB)-supported General Bathymetric (plotting) Charts of the Oceans (GEBCO).

The catalog displays the new Fishery Conservation Zone with the 200-m (Continental Shelf) and the 2,500-m (Continental Slope) zones. A list of map and chart definitions describes each of the various products available, map and chart purchasing instructions, and prices.

The catalog, "Map and Chart Catalog 5 - Bathymetric Maps and Special Purpose Maps," is available free to the public from the National Ocean Survey, Distribution Division (C44), Riverdale, MD 20840;

Counter Sales, National Ocean Survey, 6001 Executive Boulevard, Room 101, Rockville, MD; or from local marine supply agents. Copies will also be available from many boat shows early this year.

TWO MEN LOST WHEN DRAGGER SINKS

Tragedy struck in November 1977 when an 88-ft dragger sank 10 mi south-southwest of Mount Desert Rock, Maine, with five men on board. Two of the crew drowned at sea.

Late on November 11, a 35-kn southwesterly wind brought 10- to 15-ft seas, and the 41-yr-old trawler SEA BREEZE with 40,000 lbs of groundfish aboard headed for Southwest Harbor, Maine, to seek refuge from the wind and waves. At about 6:45 p.m. a thump was felt, which was followed by another thump seconds later. The skipper stopped and checked the engine-room, which had already taken on a great deal of water. He immediately radioed the Southwest Harbor Coast Guard Station stating his position and that they were sinking and needed help at once.

The fishermen abandoned ship. Two boarded an aluminum skiff, and the other three climbed into a partially filled, five-man liferaft, which went bottom up while being launched.

The two emergency craft soom separated in the darkness. Angry waves spilled frequently onto the liferaft. The three men were wet and cold, and one of them soon began to suffer from hypothermia. They had drifted for an estimated 1-1/2 hr, when they saw helicopter lights. The men used a flashlight to signal the helicopter, which dropped a flare nearby and then flew off to find the other men. The U.S. Coast Guard helicopter returned in about 10 min and lowered a rescue basket. Two of the fishermen were rescued in the basket, but the third suffering from hypothermia slid off the raft and could not be found. The fishermen were transported to Brunswick Naval Air Station where they were transferred to Brunswick Hospital by ambulance.

The Coast Guard helicopter returned to the sinking site and, aided by the cutter DUANE, searched again for the missing men throughout the night and into the morning. Early the next day, the DUANE sighted the aluminum skiff. One man was somehow alive after 14 hr of exposure. He was also flown to Brunswick Hospital. He said his companion had not lasted for half an hour. Big waves had swamped and overturned the skiff five or six times during the night, but he had somehow managed to right it each time. That same day the cutter DUANE picked up the liferaft and found the man's floating body.

WINTER OF 1976-77 COOLED GULF STREAM SYSTEM TO UNUSUAL DEPTH

Last year's severe winter in the eastern United States caused the Gulf Stream system to give off unusually large quantities of heat to the atmosphere, according to a recent report by a NOAA oceanographer. Last year the Gulf Stream system seems to have given up more heat than usual, leaving the northwestern Sargasso Sea cooled to depths as much as 100 m (300 ft) deeper than in more moderate years. The main surprise here is that a single severe winter could so disrupt recent warming trends, according to Dr. Ants Leetmaa, an oceanographer with NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla. He described an exploratory cruise aboard the NOAA ship RESEARCHER to the northwestern Sargasso Sea last spring to observe the effects of the record-breaking winter.

The area surveyed was roughly between 67° and 73°W longitude and 32° and 38°N latitude. Instruments that sense temperature, salinity, dissolved oxygen, and other physical properties of the sea were used in the investigation. Ordinarily, seasonal cooling in the area in winter creates a "pool" of water with temperatures of about 64°F with a well-mixed layer extending from the surface to about 1,000 ft (350 m). The main thermocline--a layer where water temperature and density change sharply--occurs under this very stable layer of so-called "18-degree water." Vertical shifts of the thermocline indicate changes in the volume of the pool of 18-degree water and the extent to which the ocean has been cooled by the atmosphere.

It was found that the thermocline south of the Gulf Stream had descended significantly after last winter. In the southwestern area, the thermocline was detected at slightly more than 2,400 ft (800 m), the deepest level discovered on the expedition. In more moderate years, this thermal boundary lies between 1,800 and 2,100 ft (600 and 700 m).

It is very difficult to cool ocean water to great depths by even half a degree and push the thermocline down 100 m. Enormous quantities of heat must be removed from the water column to change water temperature at all, and the deeper the cooling extends, the more heat to be lost. For example, a half-degree temperature change in a column of water 500 m deep takes five times the heat loss of reducing the temperature by a half degree in a column 100 m deep.

Most winters do not have much effect on the volume or temperature of the persistent pool of 18-degree water, but another winter like the last one could cool it down more, increase the pool's volume, and push the thermocline still deeper.

While the processes that create the persistent pool of 18-degree water in the Sargasso Sea are not well understood, they may play a role in regulating global climate. Some scientists believe that the Gulf Stream system is partly sustained by the processes that create this relatively cold pool of water.

DEVELOPMENT OF NEW LIFEBOAT RECOMMENDED

The National Transportation Safety Board has recommended the development of "an enclosed, firesafe, self-contained lifeboat" for all large U.S. ships. The Board made the recommendation to the U.S. Coast Guard in its report on a Delaware River collision and fire in which 26 persons were killed or are missing. Encapsulated lifeboats or rescue equipment of the type installed on offshore drilling rigs have been used successfully in evacuations during fire and other casualties. The conversion or adoption of this type of life-saving equipment could significantly reduce personnel casualties in similar accidents, especially on board tank vessels.

The U.S. chemical tanker EDGAR M. QUEENY struck the Liberian tanker CORINTHOS at Marcus Hook, Pa., on January 31, 1975. The QUEENY had left a dock on one side of the Delaware, and its pilot

was attempting a 180° turn to proceed upstream when it struck the CORINTHOS. The Liberian tanker, which was unloading its crude oil cargo at the British Petroleum Company dock on the opposite shore of the river, was rocked by explosions and engulfed in flames. In addition to the 26 casualties, 11 persons were injured. CORINTHOS crewmen were unable to launch her lifeboats, and at least three of those who abandoned ship were believed to have died in flaming oil on the water. Damage to the QUEENY was minor, but the CORINTHOS was destroyed.

Delaware River pollution cost more than $2 million to contain and clean up, and total property damage, including many dock structures, was estimated at $20 million.

The Safety Board held that the accident was caused by the pilot's failure to safely execute a turn into the Marcus Hook channel. Contributing to the cause was the master's delay in assuming control of the vessel for 4 min after he first doubted the probable success of the turn, and the pilot's attention being divided between intership communications and conning or maneuvering of the QUEENY.

The pilot had docked or undocked the QUEENY at least 100 times, and the master assumed that the pilot would check on the maneuver as it developed and saw no need to discuss it beforehand. Neither the master nor the pilot developed a definite plan to monitor the progress of the QUEENY by positive navigational means or to set intermediate position/heading requirements which would signal the probability that the turn would not be successful.

The Board found that the typical anchor stowage on the QUEENY, with the anchor protruding beyond the side of the tanker, provided the focal point for the forces which resulted in the penetration of the tanks on the CORINTHOS. A stowage design which recesses the anchor is one type of passive protection that could have affected the outcome of this collision. Once the explosions and fire occurred, the QUEENY's crew's firefighting training probably reduced the amount of ship damage and number of personal injuries aboard their ship.

The Board recommended that the Coast Guard (1) require masters and pilots to discuss beforehand and agree to the essential features and relevant checkpoints or maneuvers expected to be undertaken; (2) require a rate-of-turn indicator on the bridge of all ships of 10,000 tons or more; (3) develop specifications for an enclosed, firesafe, self-contained lifeboat for use on all oceangoing vessels of that size; and (4) require that anchors be stowed in hull recesses. In addition, the Maritime Administration of the Department of Commerce was asked to speed the completion of its firefighting training curriculum and program for merchant marine officers and seamen.

EXPERIMENT PROBES PACIFIC FOR CLIMATIC CHANGES

A major experiment is probing the equatorial Pacific Ocean and atmosphere for clues of how this region influences North American weather and global climate.

Called the NORPAX (North Pacific Experiment) Equatorial Shuttle Experiment, the study has drawn researchers and equipment from NOAA, the Office of Naval Research, the University of Hawaii, and Scripps Institution of Oceanography to the Pacific south of Hawaii. The Shuttle Experiment, like the broader NORPAX itself, is managed by Scripps with support from the Office of Naval Research and the National Science Foundation's International Decade of Ocean Exploration program.

The Shuttle Experiment focuses on the interactions of atmosphere and ocean that produce the seeds of weather systems which eventually become storms and sweep over North America. Similarly, thermal and other oscillations deep in the equatorial ocean may be one key to important shifts in global climate. These interactions occur over various intervals of time and space and have never before been measured in any systematic way.

From November 1977 to late January 1978 the scientists took systematic, simultaneous observations of the processes that control the exchange of energy and matter between the equatorial Pacific Ocean and the atmosphere along the meridian of 150°W longitude, from 20°N to 20°S across the Equator. They employed aircraft from Navy Reserve squadrons and NOAA, moored and free-drifting buoys from Scripps and NOAA, bottom sensors emplaced by the University of Hawaii, and the University's research vessel KANA-KEOKI.

The NORPAX Equatorial Shuttle Experiment is viewed by participating scientists as a prelude to a similar but larger one to begin late in 1978 as part of the Global Weather Experiment. That project is one of a series of international studies conducted under the auspices of the World Meteorological Organization's Global Atmospheric Research Program.

In the NORPAX Shuttle scientists expect to obtain the data needed to design this larger experiment and to develop criteria for a permanent observational network in the weather factory of the equatorial Pacific.

NEW BUOY DESIGNATIONS

The WMO 5-digit international identifier system, designating buoy locations in chronological order of establishment, went into effect at 1800 on January 17, 1978. Figure 40 is a map of their locations. The following is a list of the former and the new identification numbers.

Original	10/5/77 - 1/17/78	New	Location
EB-01	41001	41001	35.0/72.0
EB-15	41015	41002	32.3/75.3
EB-04	42004	42001	26.0/90.0
EB-71	42071	42002	26.0/93.5
EB-44	42044	42003	26.0/86.0
EB-41	44041	44001	38.7/73.6
EB-34	44034	44002	40.1/73.0
EB-63	44063	44003	40.8/68.5
EB-07	44007	44004	39.0/70.0
EB-03	46003	46001	56.0/148.0
EB-16	46016	46002	42.5/130.0
EB-17	46017	46003	52.0/156.0
EB-19	46019	46004	51.0/136.0
EB-21	46021	46005	46.0/131.0
EB-20	46020	46006	41.0/138.0
EB-39	46039	46007	59.2/152.7
EB-72	46072	46008	57.1/151.7
EB-45	46045	46009	60.2/146.8

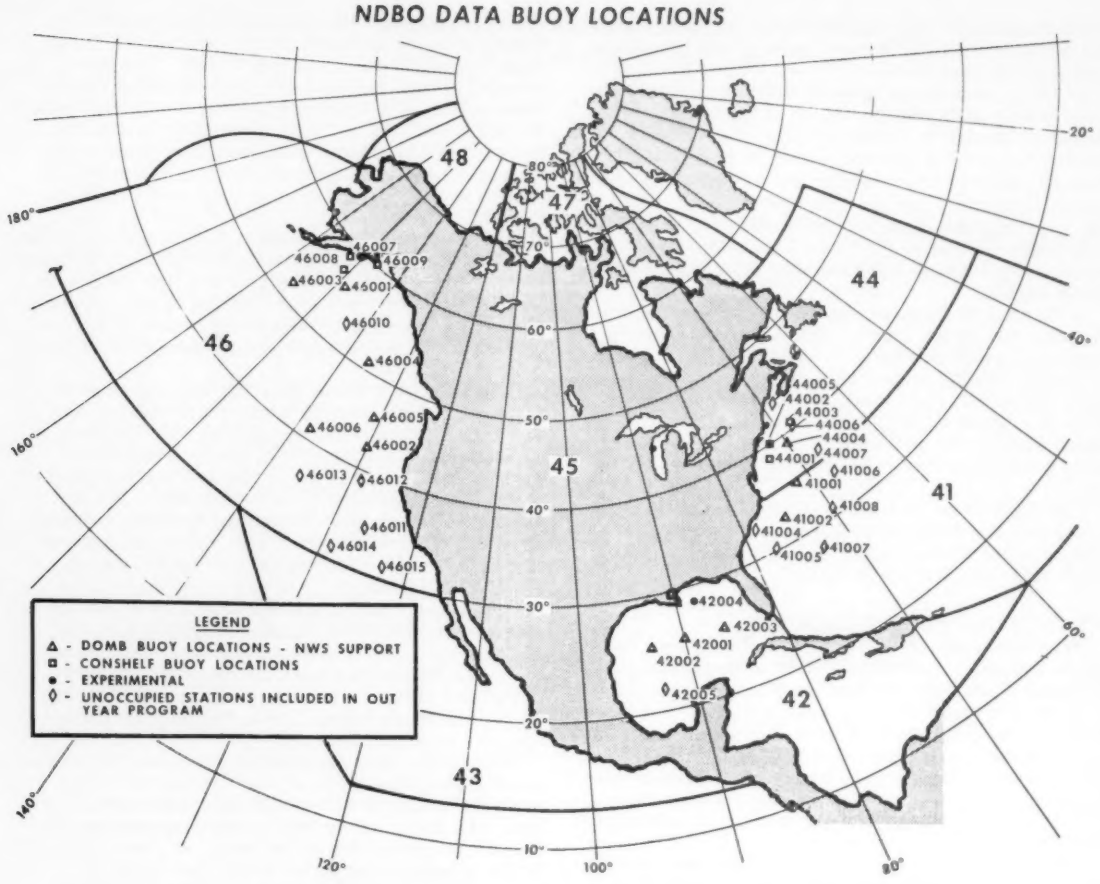


Figure 40. -- Map of North America showing the buoy locations off the coast.

LAKES WINTER TRAFFIC HEAVIEST EVER

Shipping activity on the upper Great Lakes was the heaviest ever for early winter this year, largely due to the iron ore miners' strike in the region that did not end entirely until Christmas. The strike began August 1, 1977, and for the rest of the summer and through the fall, much less iron ore than usual was received by the steel mills farther down on the Lakes. As a result, the amount of ore that mills generally stockpile for use during the winter fell to unsatisfactory low levels. To help replenish these inventories more bulk vessels than usual continued to sail beyond the traditional December layup time, and several major Lakes' carriers kept operating as long as weather and ice conditions permitted.

Indeed, if these conditions allow, navigation in the Upper Lakes could continue uninterrupted into spring, as was the case in the winters of 1974-75 and 1975-76, when vessels transited the locks at Sault Ste. Marie, Mich., year-round. The conditions described below were in early January.

That Lakes' vessels are sailing at all in January is a result of the U.S. Navigation Season Extended Demonstration Program, which was authorized by Congress in 1970 and subsequently renewed through September 1979. The program, which also is testing the feasibility of a longer shipping season on the Montreal-Lake Ontario section of the St. Lawrence Seaway, is overseen by a Winter Navigation Board. Representatives of 10 Federal agencies and interstate organizations sit on the board, including those from the Coast Guard, St. Lawrence Seaway Development Corp., and the Corps of Engineers, which serves as the lead agency.

United States Steel Corp., which has the largest fleet on the Great Lakes, reported that 6 of its 32 vessels were operating, carrying taconite pellets from Two Harbors, Minn., to Chicago and Gary, Ill. They hoped to be able to run some ships as long as possible this winter. In the past few extended seasons, U.S. Steel has maintained winter operations longer than most other Lakes' carriers.

All 13 of the operating vessels in the fleet of Cleveland-Cliffs Iron Company were sailing, representing the longest season ever for continued operation of the company's entire fleet. If it had not been for the iron ore miners' strike, perhaps at least half of the fleet would have been laid up for winter. The Cleveland-

Cliffs vessels are carrying iron ore from Lake Superior and northern Lake Michigan to several steel-company customers farther south.

Of the 18 vessels operated by Oglebay Norton Company, 9 were still sailing. Seven of the 19 vessels in American Steamship Company's fleet were also in operation, carrying taconite pellets to steel plants. Pickands Matther and Company had four of its eight vessels operating, and Bethlehem Steel Corporation was operating one out of the four boats it employed in 1977 (Bethlehem has a total of six vessels in its fleet), transporting iron ore from western Lake Superior to Burns Harbor.

A number of Canadian carriers also continued to operate ships on the Lakes. One Canadian shipping source explained that there is less Canadian-flag than U.S.-flag activity on the Lakes during the winter because the majority of Canadian domestic ships carry grain downbound through the Seaway system with a return haul of iron ore. The Seaway's St. Lawrence River section and the Welland Canal closed in December.

The Ninth Coast Guard District in Cleveland reported that there were four Coast Guard icebreakers working in the Upper Lakes--one 280-ft vessel, one 180-ft ship, and two 110-ft crafts.

OCEANIC SOCIETY CLEARINGHOUSE

Progress in marine biology and oceanography has always depended upon the availability of vessels. To help collect information about the World's oceans and to lower the cost of such research, the Oceanic Society, a nonprofit organization devoted to protection of the marine environment, has developed a Clearinghouse. Its purpose is to bring together information on scientists and their requirements for the collection of marine data and yachtsmen willing to make their vessels available as research platforms.

If you are planning a voyage during the next year and are willing to include a researcher on board for any portion of your trip, or you are willing to collect data or make observations from your vessel, the Oceanic Society is most interested in communicating with you. Examples of Clearinghouse projects already accomplished or currently in progress include: Marine Mammal Observations, Marine Pollution Monitoring, Fish-Invertebrate-Shell Collecting, Fish Tagging, Temperature and Salinity Sampling, Meteorological Observations, Underwater Communications Research, and others.

If you would like to participate in this important program, contact Dr. Michael Herz, Clearinghouse, The Oceanic Society, 240 Fort Mason, San Francisco, CA 94123, or telephone (415) 441-1104.

HURRICANE ANITA MAY HAVE DRAWN POWER FROM WARM SEA

As tropical storm Anita rapidly intensified into a hurricane last August, she may have drawn part of her power from a pool of warm water in the Gulf of Mexico and cooled Gulf surface waters several degrees.

These preliminary conclusions came from measurements made by scientists at NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., and aboard NOAA aircraft and Texas A&M University research ship GYRE. The measurements could be the most complete set of direct observations of a hurricane drawing its energy from the warm sea. This unique opportunity to observe these crucial hurricane-sustaining processes came as tropical storm Anita began to form in the Gulf of Mexico in late August, moving over a warm eddy in the Gulf.

The eddy--a slowly rotating, 150 mi (225 km) wide pool of water about a degree warmer than surrounding Gulf water--had been discovered a month earlier by Harris B. Stewart and John Proni of NOAA. Its continued existence was confirmed on August 28 by a Texas A&M oceanographer aboard the GYRE as the storm developed.

The next day a NOAA research aircraft probed Anita, and flight meteorologist Peter Black took water-column temperature profiles with airborne, expendable bathermographs. These devices are dropped into the ocean and radio back measurements of water temperatures at various depths. These measurements were supplemented by water-column observations made by the GYRE, when the ship returned to the same area of the Gulf about 10 days after Anita's passage.

Preliminary analysis of the data showed that the disturbance intensified steadily to tropical-storm strength as it moved toward the center of the warm eddy. As the storm passed the western boundary of the eddy about 18 hr later, a deepening trend in central pressure began. Anita reached hurricane force a short time later.

Although at least six other storms have followed a similar deepening trend as they crossed the Gulf, Anita is the first for which detailed oceanographic data exist immediately before and after the storm. The thermal structure of the warm eddy was drastically altered in the upper 600 ft (200 m) of the ocean. Surface temperatures were more than 7°F cooler after Anita's passage.

The apparent cooling effect of the storm seems to have extended far beyond the boundaries of the eddy. Measurements made by NOAA environmental buoys and a NOAA satellite indicate that the surface temperature of a large part of the Gulf of Mexico decreased by an average of nearly 4°F. The observations may hold important implications for understanding the ocean's role in hurricane formation. The warm eddy appeared to have started with a breakoff of the Gulf of Mexico Loop Current.

JANUARY 1978 SETS RECORDS

National Weather Service weather statistics for January 1978 have verified that the month was one of the coldest and snowiest on record in much of the nation east of the Rockies. Mariners away from home may find these statistics interesting.

For many cities in the Northeast, it was not only the snowiest January, but the snowiest month ever on record. The following cities set new snowfall records for January.

--- JAN. 1977 MEAN SNOW LINE
— JAN. 1978 MEAN SNOW LINE
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Figure 41.--A comparison of the snow line for January 1977 and 1978. The primary difference is over the mountains in the west.

City	Snowfall (in)
South Bend, Ind.	86.1
Cleveland, Ohio	42.8
Lansing, Mich.	34.0
Houghton Lake, Mich.	33.3
Trenton, N.J.	20.6
Rochester, N.Y.	60.4
Albany, N.Y.	40.8
Burlington, Vt.	42.3
Boston, Mass.	35.9

For South Bend, Cleveland, Lansing, and Houghton Lake, it was also the snowiest month ever. Other areas were hit hard also. It was the second snowiest January on record at St. Louis, Mo., with 22.9 in, and at Nashville, Tenn., with 12.9 in.

Cold temperature records were also broken in January. Cities reporting the coldest January included:

City	Average Temp.	Below normal
Sioux Falls, S.Dak	1.9	12.3
Wichita Falls, Tex.	30.1	11.4
Dallas, Tex.	33.8	11.0
Fort Worth, Tex.	33.8	11.0
Houston, Tex.	40.8	11.3

Many other areas from the Northern Plains to the western and central Gulf States experienced one of the coldest Januarys on record with average temperatures 10°F or more below normal.

Providence, R.I., had the wettest January on record with a total 9.01 in of precipitation. Sacramento, Calif., had the fifth wettest January on record with 9.61 in.

There was one record set that was not unpleasant. At Phoenix, Ariz., the average temperature of 56.6°F was 5.4°F above normal--the warmest ever for January.

About 72 percent of the land mass of North America--an estimated 6.8 million sq mi--was snow covered in parts of January, surpassing the snow cover of a year ago, as shown by NOAA satellite pictures in figure 41. Parts of California, Oregon, Washington, Idaho, Nevada, and Utah, which escaped snow last year, were covered during January 1978. This January's North American snow cover was the most extensive in the 12 yr that NOAA satellites have been making these measurements. Except in the western United States, the snow cover line for this January in the continental United States was almost identical to that of a year ago. In January 1977 about 70 percent of the North American land mass was snow covered.

NOAA SCIENTISTS STUDY ICE AGE CLIMATE

During the last ice age, as arctic cold crept into normally temperate areas, sand dunes and desert claimed the tropical continents, according to an arid picture painted by a climate model. The climate study is being conducted at NOAA's Geophysical Fluid

Dynamics Laboratory in Princeton, N.J., to determine how the geographic features of ice-age climate are maintained and what could cause an ice age in the first place.

The modelling study, which attempts to explain past climatic fluctuations in the hope of predicting future ones, also tends to support the theory that the ice age itself may have been caused by a change in the Earth's orbit. In one experiment an advanced computer model of the atmosphere was used to re-create conditions during the last ice age, 18,000 yr ago. Data on such things as ice cover, sea surface temperature, and reflectivity of the Earth's surface, as they are today and as they were during the ice age, were fed into the computer, which simulated the July and August climate of the two contrasting eras.

According to the model, both the rate of evaporation and of rainfall during the ice-age summer were smaller than today. However, the difference in climate was not uniform; the tropical oceans received more rain, while the tropical continents were more arid during the ice age. The aridity of tropical continents is corroborated by geologists, who have found evidence that during the last ice age the Sahara extended much farther toward the Equator, with sand dunes covering the northern portions of tropical Africa, where grassy savanna now reigns.

There are now many theories about what caused the ice ages. One is that they happen because there is an atmosphere, an ocean, and ice--each tied to the others and each evolving at a different rate. An ice age may occur as a manifestation of a long-term fluctuation of climate, part of an interactive oscillation.

Another more testable theory is that ice ages were caused by changes such as the tilt of the Earth's axis of rotation and the eccentricity of the Earth's orbit. This theory, originally proposed some 35 yr ago, has been supported by sediments recently collected from the sea floor, and scientists are now giving it more serious consideration. NOAA scientists subjected the orbital theory to another kind of test, by feeding many sets of past orbital parameters--which can be precisely calculated--into a highly simplified mathematical model of the ocean-atmosphere system. For different latitudes and seasons, the model computed temperatures of two layers of the atmosphere, surface temperature of land and ocean, the depth of snow over land, and the thickness of sea ice. The researchers then compared the time series of the simulated climate with the evolution of the Earth's climate, as inferred from the geological record. There were some discrepancies between the results from the model and from the geological record. But on the whole, the scientists believe that a substantial portion of climatic variability on the time scales they studied can be attributed to the atmosphere's response to disturbances in the Earth's orbit.

JAPAN HIT BY SECOND FEWEST TYPHOONS IN 1977

Japan escaped with the second fewest number of typhoons in recorded history in 1977 according to the Japan Meteorological Agency. The agency said that thanks to the recurrence of high-pressure zones over the typhoon-generating regions and a little luck, only one typhoon made a direct hit on the main islands of Japan in 1977, tying 1946, 1958, and 1973 for the smallest number on record. However, considerable damage was done to the tiny island of Okino-Erabu-Jima off Kagoshima, when it was blasted by typhoon Babe in early September.

Only 21 typhoons passed in the vicinity of Japan this year, second lowest to the 19 typhoons recorded in 1969. The greatest number of typhoons in 1 year was 44 in 1950, followed by 39 in 1967.

The agency, which began keeping typhoon records in 1941, attributed the low number this year to continued good weather in typhoon-generating regions in the western Pacific north of the Equator as a result of a high-pressure zone. Cooler ocean temperatures in the waters around the Mariana Island group was also thought to be a factor.

EARTH GAVE WARNING OF 1975 HAWAIIAN QUAKE

A major earthquake which struck Hawaii in 1975 was preceded by several months' warning from nature, according to the Cooperative Institute for Research in Environmental Sciences (CIRES) in Boulder, Colo.

It was found that vibrations from other earthquakes far distant from Hawaii slowed down as they passed through the area where the major Hawaiian quake occurred. Apparently, the seismic velocity decrease was a symptom of the stress buildup eventually released in an earthquake registering 7.2 on the Richter scale at Kalapana on the island of Hawaii.

A number of scientists at CIRES--a joint endeavor of NOAA and the University of Colorado--and elsewhere are studying such earthquake precursors, in hopes they may someday lead to accurate predictions of quakes.

The pressure waves from an earthquake travel through the Earth at a rate that varies with the properties of the crust and mantle. Seismological stations in Hawaii, part of a volcano observatory network run by the U.S. Geological Survey, routinely monitor the rumblings of the islands' volcanoes and pick up more distant disturbances, including seismic waves from the active Fiji and Tonga island chains some 3,000 mi (4,800 km) away. In comparing the waves' arrival times at three stations in the observatory network, it was found that beginning about 3-1/2 yr before the Kalapana earthquake, a given signal from one of the Fiji quakes took about 1/5 sec longer to reach the station nearest the Kalapana epicenter than had previous signals. The travel time returned to normal a few months before the quake occurred.

The other stations showed no such change and did not change relative to each other. This may mean that the slowing down of seismic signals was caused by some change in the immediate vicinity of the station; a more widespread or distant cause would have registered on instruments at the other stations as well.

Such seismic signal delays preceding a quake have been observed before, but results have been mixed. The Kalapana case suggests an explanation. The horizontal area over which the seismic slowdown occurred was unexpectedly small for the magnitude of the earthquake which followed, suggesting there could have been a very restricted zone of intense stress buildup where the break initiated, while the rest of the much larger rupture surface remained at a lower stress state. Such a precursor might be missed unless there is a long-term seismic array very close to the earthquake.

There are several equally plausible explanations

for the seismic slowdown. One is that increasing stress opened a series of tiny subterranean cracks around Kalapana. These cavities would in effect change the net composition of the Earth and could account for the observed slowing of the seismic waves. Later, water vapor would fill the cracks, and the seismic velocity would return to near normal levels. The quake itself would relieve the stress and close the cracks once more.

This type of cracking behavior has been observed in laboratory tests, but the field data are equivocal, and the role of water vapor is largely theoretical. Another equally possible explanation is that there were cracks, but no water vapor. Hopefully, monitoring of the site for several years following the quake will shed light on the phenomenon and its potential for earthquake prediction.

Figure 42.--Walter Stoddard, Port Meteorological Officer, New York.

PORT METEOROLOGICAL OFFICER RETIRES

Walter Stoddard, the Port Meteorological Officer, National Weather Service Forecast Office, New York (fig. 42), has retired and moved from Yonkers, N.Y., to Tuscon, Ariz., after 35 yr of Government service. Twenty years were with the National Weather Service. Mr. Stoddard served in the United States Navy from November 1942 until June 1946. He had a temporary appointment with the Atlantic Weather Patrol from 1949 to 1950, worked for the Post Office from 1951 to 1958, and returned to the Atlantic Weather Patrol in Boston in July 1958. In 1959 he went to La Guardia airport as a meteorological technician and then to New York City and the Marine Section in January 1961. He became the Port Meteorological Officer in 1969. His last day of duty was January 27, 1978.

Mr. Stoddard has received numerous letters of accommodation from captains of ships that he serviced. In 1973 he was awarded the Department of Commerce Bronze Medal, an achievement not attained by too many. Everyone who ever worked with him knew him as a cheery, pleasant, willing, and capable hard-working person. We will all miss him.

SURVIVAL SUIT SAVES WOMAN

During the third week of October 1977 the small crab boat EAGLE, out of Ketchikan, went down on the west coast of Alaska south of Sitka. The skipper, Rick Nelson, died in the chilly Gulf of Alaska after he gave the sole survival suit to his companion, Nancy Zaic of Lansing, Mich.

The survival suit kept Nancy warm enough to sustain life as she made her way to the nearby shore of an island and during the 10 days she wandered along its beaches seeking help. Finally, on October 29 a helicopter searching for the EAGLE rescued Nancy and took her to a hospital in Sitka. Staff members there said she was in pretty good shape, all things considered.

During her ordeal, she had eaten nothing whatsoever, but had been able to find plenty of good water in the numerous streams on the island. In a report to the Coast Guard, she said:

"It began to blow up pretty strong and we began taking on water over the bow. Rick gave me the wheel and went below to check out his engine because we didn't want to lose power, of all things.

"When he came up, he looked astern and said 'We're sinking!'

"The bow was way up in the air and the stern was underwater already.

"He got on the radio but no one was answering. So he got the dinghy down from atop the wheelhouse and put in a sleeping bag, blankets and warm clothes and what food he could grab right away. Then he gave me that survival suit and made me put it on while he got into a lifejacket."

The pair launched the little boat, but it quickly rolled over in the heavy seas. The skipper drifted away from his companion and was not seen again, but Nancy finally made it to the beach. Ashore, she slept in rock shelters or under trees in the dense forest and was kept alive and warm by the survival suit.

LETTERS TO THE EDITOR

The following letter was received from the master of the MARINE CHEMIST. The summit of Agua is 12,310 ft and the Fuego is 12,582 ft in elevation. A rough check in Bowditch indicates the summits extended a little over 1,000 ft above the horizon at a distance of 119 mi with the observer at sea level.

SS MARINE CHEMIST
Call KMCB
Marine Transport Lines
60 Broad Street
New York, NY 10004

Houston Area Weather Service
Route 5, Box 1048
Alvin, TX 77511

Dear Sirs:

While on passage from San Francisco to Balboa, we observed the Guatemalan volcanoes A. Agua and V. Fuego, bearing 356.5 and 000.5 degrees, at a distance of 119 miles, the smoke and cone-shaped tips plainly visible.

Ship's course, 125 degrees
Wind, light airs Sea, calm
Temp., Dry 85°F Wet 72°F Sea 78°F Bar. 29.99 inches

Trusting you may find this information useful, I remain,

Very truly yours,

William J. Lindros, Master

NEW PMO FOR NEDERLAND, TEX.

Henry Ramirez (fig. 43) is the new Port Meteorological Officer in Port Arthur, Tex. He replaces Larry Cedotal and will be responsible for weather support from Lake Charles to Galveston.

A veteran of 25 yr of weather work, Henry was employed by a private meteorology company in Houston after retiring from the Air Force. Since joining the National Weather Service, his assignments have been at Houston and Del Rio, Tex.

Figure 43.--Henry Ramirez, the new Port Meteorological Officer at Nederland, Tex.

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 47-50], climatological data from U.S. Ocean Buoys [table 5], and gale and wave tables 6 and 7), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

September and October 1977

SMOOTH LOG, SEPTEMBER 1977--This was the month of the "Great Lakes Trail." The favorite path for storms was almost due east across the Lakes. An isolated storm moved across the southeastern United States, and several storms moved across Canada, but there was no other concentration. The Great Lakes track was joined near Nova Scotia by a secondary track off the northeast coast of the United States. Near this point the track forked, with one path to the northeast toward Iceland and the other path eastward to later turn northeastward.

The gross pressure pattern matched the climatic pattern in the location and pressures of the major pressure centers. The Icelandic Low at 1004 mb was midway between Kap Farvel and Iceland near 62°N, 30°W. The Azores High was 1022 mb and centered near 33°N, 27°W. It extended into western Europe with two other centers, a 1022-mb center off Portugal and a 1024 mb near Le Havre. There were other low centers over the Greenland and Kara Seas.

The pressures over the Mid-Atlantic and major shipping lanes were near normal. The two major anomaly centers were a positive 9 mb over Hudson Strait and another positive 9 mb over the English Channel. These positive anomalies and the pressures associated with them give an indication of why the storm tracks followed the paths they did.

The upper air pattern at 700 mb was near the climatic normal, except for the location of the major troughs. The trough that is normally over the U.S. East Coast was displaced eastward over the water. The trough that normally parallels longitude 10°W was displaced westward to approximately 25°W, and a ridge line paralleled longitude 5°W. The major anomalies were both positive and matched the location of their surface counterparts.

There were three tropical cyclones--hurricanes Babe, Clara, and Dorothy. Their descriptions can be found in the article "North Atlantic Tropical Cyclones, 1977" on page 79 of this issue.

Extratropical Cyclones--This storm was over Hudson Bay on the 1st. At midday on the 2d, it was 990 mb over the Labrador Sea where the N. B. MCLEAN, east of Hopedale, braved 35 kn, near-freezing gales and 12-ft seas. As the storm passed north of OWS Charlie on the 3d, she measured 40 kn with 16-ft seas. A ship a few miles north of Charlie registered 48-kn winds and 23-ft seas. In 24 hr the central pressure of the storm dropped 30 mb to 960 mb at 1200 on the 3d. Many ships were reporting gales of 35 to 45 kn. The OAKWORTH at 55°N, 35°W, reported the highest waves of 26 ft.

At 0000 on the 4th, the 960-mb storm was near 61°N, 30°W. The NAWORTH (59°N, 30°W), the ATLANTIC CONVEYOR (56°N, 27°W), and another ship near 57°N, 35°W, all reported 55-kn winds. The highest seas were 30 ft by the NAWORTH. The UNI-

WERS WROCLAWSKI fought 60-kn winds near 54°N, 35°W, on the 4th at 1200. OWS Lima was tossed by 50-kn winds and 28-ft seas. Waves up to 25 ft were common. At 1800 Lima reported swells of 41 ft.

On the 5th the LOW turned northward and moved over the Faeroe Islands. It was still causing 20-ft waves over the northern shipping lanes. By the 7th the center was over the Barents Sea.

On the 4th a front stretched eastward from the Carolina coast. Minor waves were rippling along the front, and the BLUE BIRD reported a waterspout off the coast at 1300. Severe thunderstorms were reported through the morning. Heavy fog closed the Soo Locks for a time during early morning of the 8th.

Several LOW centers combined near the end of Lake Superior on the 1200 analysis of the 4th. The storm moved across the Lakes bringing rain and thunderstorms to the area. On the 6th the LOW nearly dissipated as it traversed the St. Lawrence River Valley, but it gained strength on the 7th near the coast. At 1200 on the 8th the storm was centered near 58°N, 50°W. A Brazilian-registered ship near 53°N, 46°W, was tossed by 18-ft seas. The C. P. DISCOVERER (53°N, 59°W) was just east of the point of occlusion at 1800 with high winds. Three ships off of Belle Isle reported 50- to 56-kn winds. The SUGAR PRODUCER found 40-kn winds with 30-ft swells about 300 mi directly below the storm center on the 9th. On the 10th the storm stalled southwest of Iceland and disappeared on the 11th.

This storm formed over the high plains and mountains of northern Wyoming and southern Montana on the 8th. On the 9th it moved from Minnesota into southern Canada, producing thunderstorms over Lake Superior. The CHARLES M. BEEGHLY south of Ile Royale in Lake Superior measured 56-kn winds and 15-ft seas. By 0000 on the 10th, the center was 991 mb north of Sault Ste. Marie. A boat on Lake Superior measured 55-kn winds and waves of 15 ft. The island of Isle Royal also measured 55-kn winds. Storm and gale warnings were posted for Lakes Superior and Huron. Later on the 10th, winds of 50 kn were reported on Lake Ontario. At 1800 two boats on Lake Huron reported 60-kn winds with 8-ft seas. This LOW disobeyed the normal rule and weakened as it approached and moved off the coast. It disappeared west of Kap Farvel on the 12th.

A front over the middle Atlantic was following the Azores High as it retreated eastward toward the continent. Another High was following out of Canada and New England. Several waves had moved northeastward along the front during the previous days. The 1200 chart of the 11th showed a more stable LOW with a larger circulation near 45°N, 29°W. The AMERICAN ALLIANCE was north of the center near 48°N, 30°W, with 35-kn gales and 20-ft seas and swells. A ship identified as PESD at 47°N, 32°W, had roaring 60-kn winds from the north and 36-ft swells. At 1800 the PESD and PJCM reported 45-kn gales and 26-ft swells. As the LOW was moving southward, it was squeezed between three high-pressure cells. On the 12th a ship south of the center encountered swells of 18 ft. Later that day the 1004-mb LOW stalled near 40°N, 30°W. On the 14th the storm was absorbed by a new system moving in from the west.

This was a north latitude storm. It formed off Scoresby Sound on the 13th. A fishing vessel reported 45-kn winds near the southeastern coast of Iceland. By 1200 a half-dozen ships reported winds of 35 to 40 kn in the vicinity of Iceland. The LOW was 975 mb at 0000 on the 14th. The DISCOVERY was near the Outer Hebrides with 40-kn winds and 28-ft seas. Two land stations on the coast of Norway reported 45-kn winds from the south. Ships in the Norwegian Sea were fighting 35- to 40-kn winds, and the seas were generally 10 to 20 ft. A ship near Spitsbergen had 48-kn winds. On the 15th a ship that may have been OWS Mike measured 40-kn winds and 20-ft seas. Later in the day the LOW suddenly dissipated, and a LOW near Leningrad became the major circulation center.

Cyclogenesis occurred over Lake Erie on the 13th. The storm developed rapidly and was a 992-mb LOW as it moved over Nova Scotia on the 15th. It brought rain and strong winds especially in the northern sector as it moved eastward. The Magdalen Islands in the Gulf of St. Lawrence reported 40-kn winds. The ARCTIC TROLL was hit by 50-kn and higher winds at 0000 and 1200 with 20-ft waves at 1200 near 42°N, 63°W. The SEA-LAND PRODUCER (49°N, 40°W) found southerly 55-kn winds, 10-ft seas, and 15-ft swells on the 16th. Gales of 35 to 45 kn and seas up to 15 ft continued in the southern half of the storm. The PRINCESS OF TASMANIA reported 55-kn northwesterly winds just off Hamilton Inlet on the 17th. Two ships in the vicinity of 53°N, 50°W, were battered by 20- and 23-ft swells. The HASTINGS (52°N, 50°W) suffered heavy rain, 52-kn winds, and 20-ft waves.

On the 17th and 18th the storm center looped counterclockwise near 56°N, 46°W, with the pressure slowly rising. On the 19th the LOW was only an area of weak gradient south of Kap Farvel.

The ocean north of latitude 35°N was very diffuse with multiple LOW and HIGH centers. The Azores High and a high-pressure center north of Scotland were the most prominent features. At 0600 on the 21st, a new center was analyzed near 49°N, 43°W. By 1200 it was a prominent feature with several 40-kn wind reports. At 1200 on the 22d, the 990-mb storm was near 45°N, 30°W. The two HIGHs were weakening and retreating. Several ships reported gales or stronger. Among these were the IRISH OAK (40°N, 31°W) with 44-kn winds and 20-ft seas and the CITY OF GUILDFORD (40°N, 36°W) with 37 kn and 21-ft waves.

On the 23d the storm was moving northward at 980 mb. Two U. S. S. R. ships both east and west of the center found winds over 40 kn at 1200. The UUWI had 25-ft seas on the west side of the center near 52°N, 29°W, and the RIGG had 21-ft swells on the east side near 53°N, 13°W. At 1800 the RIGG had 55-kn winds and 18-ft swells. The LOW disappeared south of Iceland on the 25th.

This was an inland storm that affected only boats on the Lakes. It developed over Colorado on the 23d. Early on the 24th it was 990 mb over the Dakotas bringing them rain and thundershowers. Later in the day the G. M. HUMPHREY and the JOHN DYKSTRA

were on northern Lake Michigan with 44- and 42-kn winds, respectively. The LOW was moving eastward very slowly, and by 0000 on the 25th it was 996 mb over northern Minnesota. By that time the G. M. HUMPHREY was on Lake Huron with easterly 42-kn winds and 13-ft seas.

Late on the 26th this circulation died, and a new one formed north of Lake Ontario.

This LOW developed east of one that had moved out of Quebec and into the Gulf of St. Lawrence on the 28th, near 52°N, 51°W. South of the center the ATLANTIC CAUSEWAY was sailing with 20-ft swells. The storm was caught under the center of very strong upper air zonal flow, especially for this time of year. It raced northeastward and at 0000 on the 29th was at 59°N, 34°W. Ocean Weather Station Charlie measured 35-kn winds, 20-ft seas, and 23-ft swells. Lima also had 35-kn winds, but the seas had built to only 12 ft. Twelve hours later she had 40-kn winds and 20-ft swells. Gales continued in the southern part of the storm as it was absorbed by another over the Norwegian Sea. The combined storm moved over Scandinavia.

Casualties--There were no notices of weather-related casualties this month.

SMOOTH LOG, OCTOBER 1977--This was an average month for storms across the North Atlantic shipping lanes. The primary path that affected ships stretched from the east coast of the United States to Iceland and into the Greenland Sea. The usual number of LOWs moved across southern Canada. There was an anomalous high number of Lows over northeastern Canada that moved northward over and along Baffin Bay.

The outline of the mean pressure pattern was near normal. The Icelandic Low at 995 mb was 10° longitude farther east than normal at 60°N, 20°W, and 6 mb lower in pressure. There was an anomalous 1006-mb LOW over Cape Dyer. The Azores High at 1023 mb near 33°N, 39°W, was 4 mb higher than the climatic normal and about 9° longitude west of its normal position. There was also an anomalous trough from the vicinity of Belle Isle to Cape Cod. The pressures over the United States were near normal. Over Ireland the pressures were below normal, with above normal over central Europe and the Mediterranean Sea.

The primary anomaly center was a negative 9 mb near 57°N, 20°W, associated with the deeper Icelandic Low. There were positive anomaly centers over the central ocean and the Mediterranean Sea.

Normally, the upper air at 700 mb rotates around two LOWs over the Arctic Ocean. This month, one of these was displaced farther south than normal near 77°N, 90°W. An anomalous LOW was southwest of Iceland near 63°N, 27°W. These two centers produced deeper and sharper troughs along the east coast of the United States and west of Europe. The height of the HIGH over the central Atlantic was greater than normal, and the center was about 5° latitude to the north of its normal position. This bulge produced a ridging effect north of the center, tightening the gradient considerably, with stronger winds.

Hurricane Evelyn and tropical storm Frieda occurred during the last half of the month. They are described in the annual article "North Atlantic Tropical Cyclones, 1977" on page 79 of this issue.

Extratropical Cyclones--This storm was over Newfoundland on the 1st. By 1800 on the 2d, the 994-mb storm was near 59°N, 30°W. A U. S. S. R. ship near 54°N, 40°W, reported 50-kn winds and 13-ft seas. At 0000 on the 3d, another ship from the Soviet Union near 55°N, 38°W, had 45-kn gales. At 1200 on the 4th, the storm was 980 mb. The OSTROV KOTLINE (57°N, 31°W) was sailing into 33-ft seas. On the 5th the buoy near 62°N, 30°W, measured 45-kn gales. At midday on the 6th, the storm was centered over Wales bringing heavy rains to England. The LASH ITALIA (39°N, 16°W) fought 45-kn winds, 13-ft seas, and 18-ft swells. Ocean Weather Station Romeo had 40-kn winds driving 23-ft seas. The seas were 25 ft 12 hr later.

On the 7th the LOW stalled near the Brest Peninsula. The TROLL PARK fought 45-kn winds and 26-ft seas west of the center. At 1200 on the 8th, another LOW moved southeastward and combined with this center. The PENHIR was near 52°N, 20°W, with howling 60-kn winds. To the south Romeo now had 21-ft seas. The 10,000-ton Finnish containership SOLANO arrived Madeira at 1700 on the 8th. She had lost seven containers which were stowed atop No. 1 hold portside overboard about 250 mi southwest of Lisbon in heavy weather. Cargo was also damaged inside the holds, and 8 m of portside rail was damaged. On the 9th Romeo had 23-ft seas as the LOW dissipated, and another LOW over Scotland took over the circulation. This was probably the storm which damaged the 4,429-ton Greek cargo vessel PANAGIA on a voyage from Havana. The damage was reported at Balboa.

Late on the 8th, a LOW formed in the col area between two HIGHs. It moved northeastward, and at 1200 on the 10th it was 985 mb near 50°N, 25°W. The VOLJANINE (48°N, 28°W) was pounded by 60-kn winds. Other ships in the area were contending with 50-kn winds and high seas. The TROLL PARK (44°N, 32°W) was hammered by 30-ft seas and 33-ft swells, while the C. P. DISCOVERER (51°N, 32°W) had 28-ft swells.

A ship near OWS Romeo was tossed by 25-ft seas on the 11th. The DISCOVERER now had 36-ft swells near 50°N, 25°W. At 1200 the central pressure of the LOW was 967 mb. The GENE TREFETHEN near 51°N, 24°W, was whipped by 52-kn winds, 20-ft seas, and 30-ft swells. Fishing vessels south of Iceland were tossed by 40- to 50-kn winds. On the 12th the ALBRIGHT EXPLORER also had 52-kn winds and 30-ft waves near 56°N, 13°W. The LOW dissipated on the 14th over the Norwegian Sea.

This East Coast storm formed as a frontal wave over the Gulf Stream off Florida on the 13th. At 1200 the EXXON CHESTER was off Cape Hatteras with 50-kn northerly winds. On the 14th the AMERICAN CORSAIR was south of Nantucket Island with 50-kn winds. The 998-mb LOW was just off Cape Hatteras at 1200, producing high tides from the Carolinas to New Jersey. Gale warnings covered the New England coast, and Boston had winds of 45 mi/h. Tides were running 2 ft above normal along the coast of New Jersey, and water levels of 6 in to 1 ft were over coastal roads in Delaware and southern New Jersey. Heavy rains added to the damage. The SANTA BARBARA (36°N,

74°W) was hit by 50-kn winds, 17-ft seas, and 20-ft swells.

The storm continued to move up the Atlantic coast. The EXXON BOSTON was near 39°N, 74°W, at 1200 on the 15th with 50-kn winds and 12-ft waves. Hurricane Evelyn had formed east of the storm in the warm sector at 0000, and they were moving in parallel tracks. By the 16th Evelyn had disappeared. The VAN HAWK south of Argentia had 52-kn winds. On the 18th, the storm dissipated south of Kap Farvel.

A LOW exploded over Labrador on the 13th on a front extending from a LOW that was traveling from the Great Lakes to Davis Strait. A ship north of Trinity Bay fought 50-kn winds and 21-ft seas early on the 14th. At 1200 the LOW was 980 mb and almost directly over Ocean Weather Station Charlie. The FEDSTEEL (42°N, 28°W) was engulfed by 72-kn winds at 1800. Not far away, the DART AMERICA rocked with 23-ft swells. At 1200 on the 15th, the pressure had dropped to 972 mb near 48°N, 24°W. The DART AMERICA (45°N, 36°W) was sailing westward with 50-kn starboard winds and waves of 23 ft. A ship 400 mi south of the center also suffered 50-kn winds. OWS Romeo measured 45-kn winds and 26-ft seas east of the center. On the 15th and 16th the FEDSTEEL sailing southeastward measured winds between 40 and 50 kn with seas of over 30 ft and significant swells as high as 46 ft. The C.V. LIGHTNING near 50°N, 29°W, was sailing into 50-kn northwesterly winds and 20-ft seas on the 16th. Other ships around the storm were fighting waves up to 30 ft. High winds and waves continued through the 17th, and the storm deteriorated into a trough on the 18th.

This was one of a series of LOWs that moved along the U. S. East Coast. It formed over Virginia and North Carolina on the 16th. The cold front swung rapidly eastward. A ship off Cape Hatteras reported 34-ft seas behind the front. The CHEVRON MADRID was slightly farther north at 1200 on the 17th (38°N, 70°W), where she found 45-kn winds and 33-ft seas. An American ship 3° longitude to the east was fighting 70-kn winds. The LOW was 986 mb near Boston. Ships along the coast were being pounded by 45- to 50-kn winds with waves as high as 36-ft reported by the AMERICAN TRADER. The storm continued northeastward hugging the coast and weakening. On the 19th a ship north of Notre Dame Bay was hit by 50-kn northeasterlies.

On the 20th the storm was caught in the zonal flow and intensified as it raced across the water. At 1800 the MOHAMEDIA (48°N, 28°W) was tossed by 50-kn winds and 26-ft swells. The storm was 980 mb near 55°N, 19°W, at 1200 on the 21st. The CIROLANA found 40-kn winds and 30-ft swells about 300 mi west of the center. On the 22d the storm died rapidly as another center formed near Iceland.

This was another one of the series of LOWs that moved along the U. S. East Coast. This one moved over the Appalachian Mountains late on the 19th. As the center moved over Newfoundland on the 22d, its pressure fell to 986 mb. A ship 700 mi south of the center found 40-kn gales and 20-ft seas. As the storm moved eastward, it continued to deepen. There were few reports, but a ship near 49°N, 34°W, radioed 50-kn winds. The AMERICAN LEGEND (43°N, 43°W) had 50 kn and 42-ft swells. The storm was 974 mb (57°N, 29°W) by midday on the 23d. The PACIFIC SKOU (51°N, 32°W) was hit by 80-kn winds. The AMERICAN LEGEND farther south near 45°N, 31°W, faced 39-ft swells. Another ship sailing northeastward along the front was buffeted by 64-kn southwesterly winds.

The LOW turned more northerly in its track on the 24th. It treated OWS Lima to 56-kn winds and 16-ft seas at 0600 as it passed north of her position. Late in the day the center moved over the east coast of Iceland and into the Norwegian Sea.

Lake Winnipeg spawned this storm on the 19th. It remained a weak frontal wave until it approached the Gulf of St. Lawrence on the 23d. By 1200 it was 992 mb near Corner Brook and strengthening. A Soviet ship north of Notre Dame Bay was buffeted by 62-kn bone-chilling northerly winds on the 24th. At 1200 the CIROLANA was sailing southwestward along the cold front with 30-ft swells near 51°N, 31°W. On the 25th the LOW moved over the northwestern peninsula of Iceland and was absorbed by another cyclone north of the Denmark Strait.

A deep LOW crept across Hudson Bay, and this cyclone formed over Labrador on the 27th. There was a long easterly fetch between Newfoundland and Scotland south of this center, and another LOW east of Iceland. There were reports of waves of 15 to 20 ft from coast to coast. At 0600 on the 24th, the VANCOUVER TRADER was plunging into 30-ft swells northeast of Trinity Bay. In the next 6 hr the storm deepened rapidly to 972 mb. The cyclone was near 57°N, 35°W, and the ATLANTICA MILANO (49°N, 44°W) was pounding into 50-kn winds and 21-ft seas. Other ships were contending with 40- to 50-kn winds, with the highest waves reported at 30 ft.

On the 29th a frontal wave was racing eastward between latitudes 45° and 50°N. As the small center moved, it rapidly shifted the winds and alternately relaxed and tightened the pressure gradient. The highest wind was about 50 kn, but the seas were running 20 to 25 ft over a large area. On the 30th the 962-mb LOW was south of Iceland as it absorbed the frontal wave. A large group of vessels in and north of the North Sea reported 40- to 50-kn winds. The seas varied from 15 to 30 ft. Stations along the Norwegian coast were measuring 40-kn prevailing winds. On the 31st the North Sea fleet had little respite. In November the storm continued northward over the Greenland Sea.

This was almost a November storm. The front associated with the previous storm dropped to approximately 35°N between the Azores and Madeira, which it then paralleled westward. At midday on the 31st, a frontal wave was analyzed between longitudes 40° and 45°W. The reports from three ships were especially significant in identifying this wave. It rapidly pulled cold air southward and intensified. The Greek cargo vessel TINA (1,364 tons) sank near Brest on the 31st after encountering 50-kn winds and 20-ft seas. Ten crewmembers were drowned, five were rescued by the Moroccan SELMA, and six were missing. The pressure was 988 mb by 0000 on November 1. At that time it was centered near 46°N, 35°W. The VASILIY KACHALOV was about 120 mi to the southeast, where she had 45-kn winds and 26-ft seas pounding her portside. At 1200 the English ship ARCTIC TROLL near

45°N, 23°W, found 50-kn storm winds and 21-ft waves. The 227-ton Panamanian supply vessel AMERICAN MOON put into South Hampton due to heavy weather damage. On the 2d the storm moved over the Irish Sea. The North Sea fleet again caught the brunt of winds up to 50 kn and seas over 20 ft. The 3,312-ton Uruguayan cargo vessel ESTEMAR II suffered heavy weather damage on the 3d. She was enroute Rotterdam to St. John, but was diverted to Vigo for repairs. As the storm crossed the North Sea, it faded.

Casualties--The 2,547-ton East German KARLSHORST had a cargo of timber shift in heavy weather near 67.1°N, 11.5°E, on the 25th and took a heavy list. She was towed to calm waters near Vestvagoy and sank on the 27th with only the bow visible. The crew was rescued, but the tug ATLAS collided with her while assisting and sank.

Smooth Log, North Pacific Weather

September and October 1977

SMOOTH LOG, SEPTEMBER 1977--There was very little correlation between the actual storm tracks this month and climatology. In the simplest analysis, the tracks were shifted many degrees of longitude to the west. The majority of the persistent cyclones were over or just off the Asian mainland. A fairly well-traveled path started over the western Aleutian Islands and through the Bering Sea to Alaska. Four storms wandered around the central ocean. An average of one cyclone a week approached the west coast of Canada and the United States, but only two managed to cross the mountains.

The pressure centers were also west of their climatological positions and more intense. The most obvious departure from climatology was the lack of an Aleutian Low, which is normally 1006 mb and centered over Bristol Bay. A secondary 1010-mb LOW over the Sea of Okhotsk was matched by one of 1005 mb, and another 1005-mb LOW was centered to the northeast over Siberia. The Pacific High was 1025 mb near 41°N, 158°W, 4 mb higher and about 750 mi northwest of its normal position. It was much broader to the north and west. This produced a large area of positive anomaly with a plus 11-mb center that covered most of the ocean north of 30°N. There were two negative anomaly centers of 7 and 8 mb over western Siberia near the low-pressure centers.

The upper air pattern at the 700-mb surface differed radically from climatology over the northern latitudes. The major trough that is usually over the Bering Sea appeared to be shifted westward to reinforce the normal long-wave trough over the east coast of Asia. There was a short-wave trough over western Alaska. There was also a pronounced trough off the west coast of the United States extending northward over the Canadian coast, which is normally dominated by a ridge. The Pacific High was near normal. The major anomaly was a plus 115 m, centered south of Unimak Island and reflecting the absence of the Aleutian trough. Negative anomaly centers over Siberia and Vancouver Island reflected the anomalous troughs.

There were eight tropical cyclones over the North Pacific this month. The western ocean had five, two typhoons and three tropical storms. The eastern ocean hosted two tropical storms and one hurricane.

Extratropical Cyclones--The first half of the month was relatively quiet, except for typhoon Babe over the Philippine Sea. The Pacific High was well entrenched over the central ocean. Extratropical LOWs tracked northeastward along the Asian coast.

The usual heat LOW was stationary over the Imperial Valley of southern California. On the 8th a new center developed on the eastern side of the Pacific High, tightening the gradient between the two centers along the U. S. West Coast. Late on the 9th, two ships reported winds over 40 kn. The OVERSEAS CHICAGO near Cape Mendocino had 45-kn northerly winds with 36-ft swells. Six hours later the seas were 23 ft with 39-ft swells. The CHEVRON EINDHOVEN near Cape Blanco reported 43-kn winds but only 16-ft waves. On the 10th, the HAWAIIAN MONARCH was south of the HIGH off Los Angeles with 43-kn northeasterly winds. Later in the day the AMERICAN ASTRONAUT was in the same area (33°N, 135°W) and found 57-kn winds.

By the 11th the eastern center had broken away from the main HIGH and was 1030 mb near 47°N, 136°W. The heat LOW split into two centers, one over Nevada and one over Mexico. The gradient slackened and the winds decreased.

This was the first significant extratropical cyclone for the month. It tracked across the U. S. S. R. and gained strength as it moved across the northern Sea of Okhotsk. At 0000 on the 12th it was 982 mb near 58°N, 160°E. The SOYOKAZE MARU was east of the occluded front with southerly 38-kn winds and 26-ft swells. Twenty-four hours later the pressure had fallen to 962 mb. The OHMINESAN MARU was over the central Bering Sea south of Saint Matthew Island with 40-kn southerly winds. Other ships south and east of the center were experiencing gales of about 35 kn. The GLACIER was southeast of Saint Matthew Island at 0600 on the 13th and radioed 47-kn southerly winds with 10-ft seas. On the 14th the LOW split into two centers as it crossed the Chukotskiy Peninsula.

Monster of the Month--A front over midocean pushed as far south as latitude 35°N on the 11th. It was accompanied by a sharp trough between two centers of the Pacific High. Several waves formed on the front, and on the 12th one developed into a fair-sized LOW. Two ships, the KHERSONES west of the center and the ARIZONA MARU southwest of the 1002-mb center at 41°N, 167°W, were swamped by swells of 35 ft. The HIGH to the northeast expanded southwest-

ward, and the LOW weakened and moved southward. The LOW was now associated with an inverted trough and a cutoff LOW aloft. It drifted westward in the vicinity of 35°N until late on the 17th when it turned northward as the upper air LOW again became associated with the zonal westerlies. On the 16th the TOYOTA MARU passed 400 mi north of the center and headed into 16-ft seas and 20-ft swells. At 0600 a ship far to the east of the LOW and between it and high pressure radioed 65-kn winds from the east.

On the 17th the 1006-mb LOW was centered near 34°N, 178°W. The TAIZAN MARU was 200 mi north of the center with 25-ft waves. By 1200 on the 19th the 992-mb LOW was at 47°N, 177°W. A Japanese-registered ship reported heavy rain, 40-kn winds, and 10-ft waves west of the center. On the 20th the PRESIDENT MCKINLEY experienced 40-kn winds with 18-ft waves in the northerly flow west of the storm. Another ship in the same quadrant had 20-ft waves. The VIOLET was at 45°N, 179°W, with 20-ft seas and 23-ft swells on the 21st. The storm was absorbed by a Gulf of Alaska LOW that same day.

The first chart to indicate the presence of this LOW was the 0000 chart on the 15th. The circulation was indicated by reports from the SHINANO MARU, OHMINESAN MARU, and Adak Island. The SHINANO MARU reported 50-kn winds from the west-northwest. By 0000 on the 16th, the 994-mb LOW was over western Alaska. The KASHIMA MARU was off the coast with 40-kn gales. A report from the MOBIL MERIDAN indicated 65-kn winds over the Gulf of Alaska. At 1200 the LOW was moving off the south coast of Alaska and the ARCO JUNEAU was fighting 20-ft swells. The NEWARK was headed toward Cook Inlet on the 17th with 40-kn winds from the northwest. By 1200 that day another LOW off Washington took over the circulation.

At 1200 on the 20th extratropical Emma was at 45°N, 152°E, about 300 mi east of Hokkaido. The CHIKUHO MARU was 200 mi southwest of the center with 45-kn winds and 36-ft swells. The JAPAN ACACIA was 150 mi southeast of the center also reporting winds of 45 kn but no seas in the observation. Twelve hours later the ACACIA was still fighting winds of 40 kn. Gale-force winds continued to blow, and at 0000 on the 23d the 962-mb storm was at 61°N, 170°E. The JUJU MARU reported 35-kn winds and 20-ft waves 600 mi south of the storm's center. It was now the largest extratropical cyclone of the month. Its circulation spread from Alaska well into Siberia and from the East Siberian Sea to 45°N. On the 23d land stations on the Chukotskiy Peninsula reported 35- and 40-kn winds. On the 24th the NORTH STAR III was in Kotzebue Sound with 45-kn southerly winds and 15-ft seas and swells. As the storm moved over the cold Chukchi Sea, it rapidly weakened but managed to survive until the 29th near 84°N.

As extratropical Emma moved across the eastern tip of Siberia she left a deep trough which paralleled the Kuril Islands. As the trough swung eastward, a LOW formed near 45°N, 161°E, on the 25th. Within a few hours it had broken its connection with the other circulation. The GRAND CARRIER had 45-kn westerly winds south of the center. By 1200 the LOW was 986 mb near 47°N, 165°E. The NORWAY MARU, 100 mi south of the center, had 992-mb pressure, 40-kn winds, and 15-ft swells. This was only a sample of what was to come. On the 26th the PRESIDENT JEFFERSON was sailing with 45-kn gales with 30-ft swells on her stern. At least three other ships reported seas and swells up to 25 ft in the southwest quadrant of the storm. Six hours later she had 48-kn winds and 25-ft waves. The SEA-LAND FINANCE joined in with 38-kn winds and 20-ft seas in the vicinity of 45°N, 165°E. Winds of 40 kn and seas of 20 ft continued into the 28th. On the 28th the LOW broke up into multiple centers over Alaska.

Tropical Cyclones, Eastern Pacific--Short-lived tropical storm Emily formed on the 13th near 15°N, 118°W. She was just a minimal tropical storm as winds reached 35 kn during the 13th and early 14th. Emily tracked northwestward. By the time she reached the 20th parallel near 123°W on the 14th, her winds dropped below 25 kn. One week later Florence formed along the 15th parallel near 126°W. She headed northwestward but quickly turned toward the north-northeast. Winds near her center climbed to hurricane force by the 22d, and the following day they were blowing at 90 kn. It was at this time that tropical storm Glenda was detected some 150 mi east of Clipperton Island. Heading westward she passed just north of the Island on the 24th and then turned northward. Her winds were at a peak of about 40 kn. Meanwhile, Florence's winds had fallen back to tropical storm strength. By the 24th, after crossing the 25th parallel near 124°W, she was downgraded to a depression. Glenda fell to depression strength by the 25th after crossing the 15th parallel near 109°W. She turned northwestward and passed near Socorro Island. Some semblance of a circulation persisted until the 27th, when she finally dissipated after stalling on the 26th near 21°N, 114°W.

Tropical Cyclones, Western Pacific--Babe popped up among the Caroline Islands, near Woleai, on the 2d. The following day the South China Sea spawned Carla, midway between Luzon and Hainan. Both systems moved westward. Babe reached tropical storm strength on the 2d, while Carla climbed to tropical storm intensity on the 3d. Carla's winds never exceeded 35 kn as she moved south of Hainan and into Vietnam on the 4th.

On the 5th the OHIAKI MARU, far to the north of Babe's center, ran into 20-ft swells in gale-force

winds. That same day Babe turned toward the north. The following day she reached typhoon strength and shifted her course slightly to the west of north. Winds continued to climb and by the 8th, as she crossed the 20th parallel near 127°E, Babe reached supertyphoon strength as winds hit 130 kn. Early on the 9th the FRESNO CITY, GZWL, and 7JBU all encountered 30- to 35-ft swells in the eastern semicircle of the storm. Winds ranged from 50 to 64 kn. The powerful storm turned toward the north-northeast and banged through the Ryukyu Islands near Okinawa later in the day. While traversing the East China Sea on a northwestward then westward heading, Babe caused some problems. The MAY CRUISER, a Panamanian-registered freighter, radioed on the 10th that she was in danger of sinking in typhoon-lashed seas, about 250 mi northwest of Okinawa. Nine Filipino crewmen were rescued from lifeboats, thirteen were found dead, and three were missing. Early on the 11th still packing typhoon-force winds, Babe swept over the Chinese mainland near Shanghai. In the woods, Babe uprooted hundreds of trees while her heavy rains flooded the already waterlogged fields.

A tornado was reported in association with Babe in Japan at Fukuoka City on the 8th. Babe was responsible for one death and 77 injuries in Japan. A total of 1,106 houses were destroyed and 1,053 others heavily damaged in western Japan. Hardest hit was Okinoerabu Island, where winds of more than 40 kn blew for several hours. Rainfall totals as high as 10 in were recorded.

In mid-September Dinah and Emma developed at about the same latitude (21°N) but nearly 900 mi apart. Dinah was spotted on the 14th near 128°E and moved southwestward. Emma was detected early the following day near 143°E heading north-northeastward. By this time Dinah was intensifying as she approached landfall over northeastern Luzon. Dinah crossed Luzon as a typhoon with maximum winds of 70 kn. The rugged terrain took its toll, and she entered the South China Sea heading westward as a tropical storm on the 16th. The death toll stands at 45 with several people missing. Most of the deaths resulted from drownings. Meanwhile, tropical storm Emma was heading northward across the 25th parallel near 145°E. Emma maintained a circulation with maximum winds of 50 kn from the 16th until the 18th as she jogged northwestward then northeastward passing just east of Tokyo on the 19th. Emma brought torrential rains to Japan resulting in floods and landslides on Honshu. Up to 11 in of rain fell in some sections. Hardest hit was Fukushima Prefecture where four people were killed in landslides. Altogether, six people died, with two others missing. The ARCTIC TOKYO measured 55-kn winds not too far away from the center as her pressure was 987 mb. By the next day she was turning extratropical. Dinah had moved westward then, on the 17th, recurved toward the northeast. On the 18th the VISHVA TARANG ran into 60-kn winds about 150 mi south of the center, while the NISSAN MARU reported 56-kn southwesterlies closer to the center. The STRATHAPPIN and the SHOJU MARU encountered 20- to 28-ft swells in gale-force winds. From the 19th through the 21st she meandered near 20°N, 119°E, and regained her typhoon intensity. Peak winds reached 70 kn on the 20th. On the 21st she finally headed southwestward. Dinah's intensity began to wane; by the time she reached the central coast of Vietnam on the 23d, maximum winds had dropped to 50 kn.

While Dinah was dying over Vietnam Freda was coming to life off the coast of northwestern Luzon. The tropical storm moved west-northwestward. Maximum sustained winds reached 55 kn on the 24th, before Freda moved ashore over mainland China, about 100 mi southwest of Hong Kong.

Casualties--The barge GD-3 broke from its mooring during a storm on the 13th and 14th and hit the Dillingham Drydock. The dock was damaged and the barge ran aground. The 561-ton Korean-registered JUNG KEUM No. 3 sank in rough seas off Matsure Island on the 16th. The crew was rescued.

SMOOTH LOG, OCTOBER 1977--This was a busy month for cyclones. The weather patterns were settling into a winter regime and were stronger and lasted longer but generally had not developed into the large, deep circulations of deep winter. There were two primary storm tracks: one of continental origin that traced a path eastward from over the Tartar Strait into the Bering Sea near latitude 59°N; and the other of maritime nature from south of Honshu to near 45°N, 180°, and then into the western Gulf of Alaska. A secondary track broke off the latter primary track near 40°N, 170°E, and continued eastward before it turned northeastward near 40°N, 155°W.

The mean monthly pressure pattern closely matched the climatic pattern. The Aleutian Low at 993 mb was normally located near 57°N, 150°W. This was 8 mb lower than the climatological value and produced a 9-mb anomaly near the same position. An elongated trough stretched westward to the Tatar Strait, while the southerly trough passed through 40°N, 160°W, and divided the Pacific High into two 1022-mb cells. These two cells were reflected in two plus 3-mb anomaly centers. There was the normal slight ridging over the mountains along the U.S.-Canadian coast.

In the upper air the zonal flow pattern between latitudes 30° and 60°N was normal, but the gradient was more intense, which would produce stronger winds. A LOW was centered over the Bering Strait. This center was connected to two other centers by an east-west trough that stretched into north-central Siberia. The ocean between latitudes 20° and 50°N had positive height anomalies. The area of negative anomalies was between latitudes 50° and 70°N, except south of the Gulf of Alaska where they reached approximately 42°N.

Hurricane Heather was the last tropical cyclone of the season over the eastern ocean. The western ocean hosted four tropical cyclones--typhoons Gilda, Ivy, and Jean and tropical storm Harriet.

Extratropical Cyclones--The first significant LOW this month formed south of Honshu on the 3d, as a frontal wave. It quickly developed to 996 mb 24 hr later at 1200 on the 4th near 35°N, 146°E. At that time a ship 200 mi northeast of the center reported heavy rain with 40-kn winds. Twelve hours later the ALASKA MARU was about 60 mi north of the center with 50-kn winds and 16-ft waves. A ship about 200 mi south of the LOW had 33-ft seas. Gales continued and at 0000 on the 6th

the HEIDE LEONHARDT was passing westward south of the storm with 50-kn winds and 26-ft waves.

Early on the 7th four ships very near the center of the 990-mb storm at 48°N, 165°E, had winds to 56 kn and waves to 30 ft. At this time the storm was deepening rapidly. By 1200 the pressure had plunged to 972 mb. The SAKHALIN, fishing near 53°N, 172°E, was hit by 55-kn winds and 20-ft seas. As the LOW moved over the Bering Sea on the 8th, two Japanese ships reported winds to 55 kn and swell waves to 30 ft south of the storm.

As the cyclone moved toward Bristol Bay, a ship 700 mi to the south fought 33-ft swells on her stern. On the 10th the storm was turning westward over Norton Sound and ending, but the PACIFIC WING still found 50-kn winds and 25-ft seas near 53°N, 176°W. The storm disappeared over the cold water as another LOW formed south of Kodiak Island. This now became the primary storm.

The winds and waves in the far southwest quadrant continued without regard to the change in centers. The CHIKUHO MARU (44°N, 165°W) was sailing into 40-kn gales and 25-ft swells. On the 11th a report from a ship (3FTF) near 59°N, 151°W, indicated 96-kn winds and waves of 33 ft. The CHESTNUT HILL south of the center fought 30-ft swells. The PRESIDENT MADISON was pounding into 50-kn winds and 13-ft waves on the 12th. By late on the 13th the LOW dissipated south of Anchorage.

The waters south of Tokyo spawned this storm late on the 10th. It remained only a wave until late on the 12th when the first closed isobar was drawn on the charts. The ALASKA MARU, a good reporter, sent one of the first reports of gale-force winds with 16-ft swells in the northwest quadrant at 0000 on the 13th. Three other ships reported heavy rain in the northeast quadrant. At 0600 the SANKOGRAIN radioed 54-kn northerly winds also northwest of the 1004-mb center.

By the 15th at 1200 the 986-mb storm was at 45°N, 164°W, and gales of 40 kn with waves as high as 20 ft were reported. At 0000 on the 16th the storm was analyzed at 964 mb. The KORO SEA, 240 mi west of the center, was pounded by 60-kn winds. Winds of 35 to 40 kn were measured all over the southern half of the storm. There were three reports of swell up to 23 ft as far away as 750 mi southwest of the center. The ALEUTIAN DEVELOPER was sailing northeastward south of the Alaska Peninsula on the 16th and 17th with winds ranging from 35 to 50 kn and shifting from north to northwest. The land protected her from waves higher than 20 ft. The storm was over the Gulf of Alaska at 0000 on the 17th and Ocean Weather Station Papa was fighting 40-kn winds with 31-ft seas. At 1200 the storm moved ashore. The DISCOVERER east of Kodiak Island measured 54-kn winds and 30-ft seas on the 18th.

A wave formed on the 19th on a front that paralleled latitude 37°N off Japan. Another LOW was moving southeastward over the lower Kamchatka Peninsula. By 0000 on the 20th, the LOWs were 976 mb near 50°N, 165°E, and 982 mb near 44°N, 178°E, with a combined circulation. The ASIA ZEBRA was sailing southwestward about 150 mi southwest of the northern center. Her starboard side was pounded by 55-kn winds driving seas and swells of 38 ft. A ship in the warm sector south of the second LOW was sailing into 50-kn southerly winds with 25-ft seas and 36-ft swells.

By 1200 on the 20th the southeastern LOW was the only center of circulation at 964 mb. The TOYOTA MARU found 65-kn winds near 48°N, 170°W, at 1800. The seas were 23 ft and the swells 33 ft. The 960-mb LOW was near 48°N, 161°W, at 0000 on the 21st. The FEDERAL SUMIDA was about 4° latitude to the south with 63-kn winds. Winds of 40 to 50 kn and seas over 16 ft were being reported all around the storm. At this time it was a tremendous storm. Its circulation reached from the Beaufort Sea to latitude 30°N and from the interior of western Canada west to 180°. At 0500 on the 21st the LIECHTENSTEIN at 42.6°N, 161.4°W, 450 mi southwest of the center measured 59-kn winds, 41-ft seas, and 50-ft swells 20° off the seas. At 0000 on the 22d, the storm's pressure had dropped to 950 mb near 55°N, 148°W. The EVER PROMOTER, south of the center near 41°N, 142°W, was tossed by 66-kn winds with waves of only 16 ft. A ship about midway toward the center had 30-

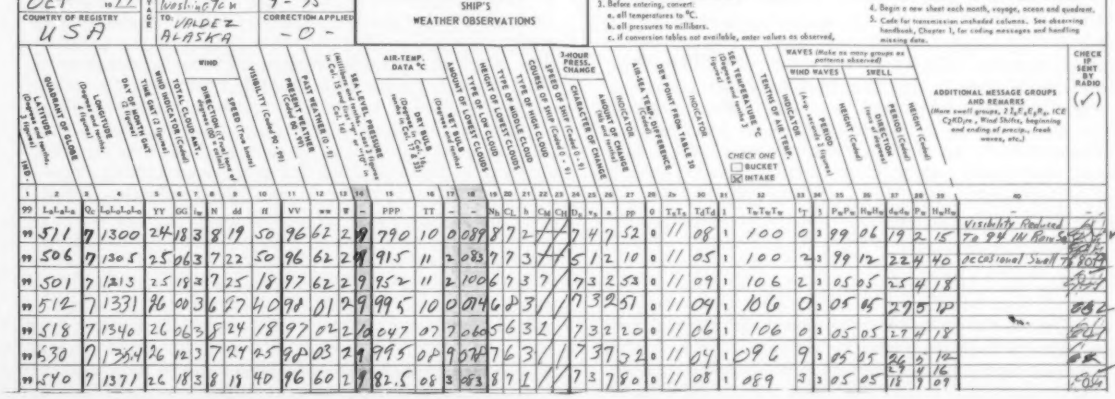


Figure 44. --The remark of "occasional swell to 80 ft" is on the second line of this 72-1. At 1800 on the 26th the OVERSEAS CHICAGO is on the fringe of the monster.

ft swells. The GREAT LAND was southeast of the LOW at 1200 with 62-kn winds and at 1800 the seas were 34 ft. Her barometer had dropped to 963 mb at 1000. On the 23d the storm stalled over the Gulf of Alaska off the coast and filled rapidly. Three U.S. ships had 50-kn winds in the vicinity of 58°N, 145°W. At 0000 on the 24th the storm was 944 mb near 46°N, 146°W. That day there were 19 reports of winds greater than 41 kn and waves 20 ft or higher by American ships. The AMERICAN MAIL (48°N, 145°W) about 360 mi southwest of the center was mauled by 60-kn winds, 30-ft seas, and 49-ft swells. The MOBIL ARCTIC closer to the center was pounded by 39-ft swells. On the 25th at 0600 the OVERSEAS CHICAGO (50.6°N, 130.5°W) had 65-ft swells, and in Remarks she indicated occasional swell to 80 ft (fig. 44). Early on the 26th the storm dissipated on the coast as the next one approached.

Monster of the Month--Typhoon Ivy was encompassed by a large circulation that resembled an egg with the small end to the north. A low center was analyzed in this north end on the 0000 chart of the 24th. A large HIGH was centered to the east and moving eastward. The storm had a good start from the warm, moist air advected into it from the circulation around Ivy. By 1200 its pressure had dropped to 980 mb. At this time the storm started racing northeastward. The 0000 chart of the 25th showed many reports of strong winds and high seas. Both the PRESIDENT LINCOLN and JEFFERSON were near 43°N, 161°E, with 55-kn winds with seas of 25 ft and swells to 34 ft. The EATON GLORIA reported fantastic 51-ft swells near 44°N, 158°E. Other ships reporting fantastic seas and swells were the GOLDENROD, 57 ft; PRESIDENT JEFFERSON, 44 ft; and the RUSH, 55 ft. The strong winds and high waves continued. Peak winds of 95 kn from the west were recorded at Adak Island at about noon. Several buildings were blown from their foundations. At 1800 the NORTH STAR III had 60-kn winds gusting to 70 kn. On the 26th at 0000 three ships reported winds of 70 kn or more, with the MORI MARU calling the swells 56 ft, while another ship claimed 46 ft. The ALEUTIAN DEVELOPER at 54°N, 162°W, reported 41-ft waves. Six hours later the swell was 51 ft. She had winds over 60 kn from 1800 on the 25th through 0900 on the 26th. They calmed to 20 to 40 kn for 24 hr, but were again 65 kn at the 0900 and 1200 observations on the 27th. It was not until after 0600 on the 27th that the swell dropped below 30 ft. She recorded a low pressure of 937 mb

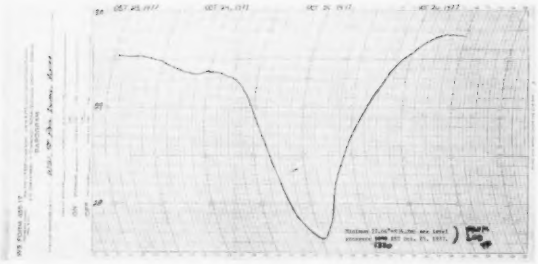


Figure 45.--The barometric pressure at St. Paul Island fell from 29.38 in to 27.64 in in 24 hr.

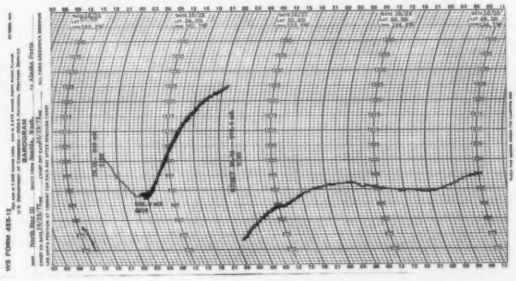


Figure 46.--The NORTH STAR III had a different type of barograph than St. Paul Island and had to reset the pen when the pressure dropped to 936 mb (27.64 in).

at 0900 on the 26th. The pen had to be raised twice for a total of 40 mb. The LOW dropped to 933 mb near 54°N, 168°W. At 0020/26 St. Paul Island recorded a minimum sea-level pressure of 936.8 mb (27.64 in) on the barograph (fig. 45). At 0600 the NORTH STAR III was at 54°N, 164°W, with her pressure showing 936 mb (fig. 46). The VIGILANT near Dutch Harbor reported a minimum pressure of 926.1 mb (27.35 in)--a new all-time record low pressure reading for Alaska. At King Cove some building materials were lost with other wind damage.

The high winds and waves continued until the 28th when the storm slowed over the Gulf of Alaska as its pressure rose. A frontal wave guided by the zonal flow south of the LOW crashed into the Washington-Oregon coast on the 30th. Another wave hit the coast on November 1. A ship off Portland was battered by 50-kn winds. Winds gusted to 50 kn along the coast of Oregon and Washington. A gust of 77 kn was clocked at Smith Island, Wash., and gusts over 105 kn were recorded at Rattlesnake Ridge, Wash. On the 2d the winds diminished.

For many additional weather reports from ships involved in these last two storms, see the Selected Gale and Wave Observations in this issue. This is only a sample of the number of observations made as only the highest wind over 40 kn and highest wave over 20 ft are listed for an individual ship for the day. The Mariners Weather Log and NOAA wish to express their thanks to all the ships that so diligently logged the meteorological observations in extremely adverse

conditions. For additional information on this storm see article on page 90.

Tropical Cyclones, Eastern Pacific--Hurricane Heather was first detected about 300 mi southwest of Mazatlan on the 4th. She was intensifying and heading northwestward. The following day Heather attained hurricane strength as she moved between Clarion and Socorro Islands. Winds near her center climbed to 75 kn for a short while. Heather retained her hurricane-force winds until late on the 6th when she fell back to tropical storm intensity about 240 mi south-southwest of Pt. Eugenia, Baja California. On the 7th Heather, now a depression, began to break up about 70 mi west of Pt. Eugenia.

Heather's large circulation triggered showers and thunderstorms over the southwestern United States. Several locations in Arizona received 1- to 2-in falls in a short period of time, causing flash floods.

Tropical Cyclones, Western Pacific--Gilda developed on the 3d midway between Wake Islands and Guam. She headed northward then northwestward. By the 5th she had crossed the 20th parallel, near 154°E, and was at typhoon strength. Gilda remained at minimal typhoon strength into the 6th but dropped back to tropical storm intensity as she crossed the 25th parallel near 149°E. Late on the 7th and on the 8th, winds climbed back up to 65 kn as Gilda began to recurve toward the northeast. At 0000 on the 9th the JFLI and the PRESIDENT TAFT encountered 40-kn winds in 16- to 20-ft swells. The following day the PRESIDENT TAFT and the JBSL reported 40-kn winds in seas up to 20 ft. Gilda was turning extratropical on the 10th as she headed east-northeastward past 165°E at about 43°N.

By midday on the 10th Gilda had become extratropical, but ships found little change in the winds and seas and heavy rain continued. On the 11th the storm was 992 mb near 43°N, 180°. On the 12th the CHESTNUT HILL was about 450 mi southwest of the center with 45-kn winds and 15-ft seas. The PRESIDENT TAFT was keeping pace with the storm and at 1200 was only a few miles south of the center with 16-ft swells.

The storm turned northeastward on the 13th and made things even tougher for the PRESIDENT TAFT, who suffered 60-kn winds, 33-ft seas, and 36-ft swells at 1800. On the 14th the winds were 55 kn, the seas had dropped to 12 ft, but the swell remained at 36 ft. The SEA-LAND COMMERCE was north of the storm near 47°N, 154°W, contending with 65-kn typhoon-force winds and 16-ft waves. Five ships reported winds of 50 kn or more in the Gulf of Alaska. At 1200 on the 14th the central pressure had again reached 958 mb. A ship 100 mi northwest of the center measured 966 mb. The TAFT was now 750 mi south of the center of the storm with only 30-kn winds, but the seas were 16 ft and the swells 26 ft. At 1200 on the 15th the GREAT LAND was near 56°N, 140°W, and headed toward Cook Inlet with 60-kn winds out of the south. Her pressure dropped to 979 mb. On the 16th the storm crossed the coast near Valdez and disappeared.

Harriet was spawned on the 16th near 15°N, 135°E. She moved northwestward until the 17th when she recurved northward. By this time Harriet was a tropical storm. On the 18th the OXIT 150 mi northwest of the eye and the JEKH some 80 mi east of the eye ran into 35-kn winds. Seas were running 20 ft to the northwest and 25 ft to the east. Maximum winds were 55 kn near the center on the 18th. This was Harriet's peak intensity. She turned toward the northeast on the 19th. By the 20th she turned eastward and started to become extratropical.

Extratropical Harriet continued an easterly movement and at 0000 on the 21st was only a weak 1004-mb LOW. A building HIGH was following across Japan fast on the heels of the developing storm. The DOLLY TURMAN near 34°N, 149°E, was nearer the HIGH than the LOW, but the winds were 55 kn out of the northeast. The LOW was racing eastward at 45 kn. By 0000 on the 23d the 976-mb center was at 41°N, 158°W. As it passed north of the ORIENTAL EDUCATOR, her winds increased to 68 kn. There were eight reports of winds 40 kn or greater and waves as high as 25 ft.

At 0000 on the 24th, the storm's central pressure had dropped to 944 mb--probably lower than when it was a tropical storm. Shipping was really getting battered by high winds and waves. The HARFLEUR at 39°N, 142°W, had 70-kn winds and 30-ft waves. while the VLADIMIR MAYAKOUSKIY (40°N, 145°W) had 62 kn and 39-ft waves. Many other ships reported winds in the 50-kn and seas in the 20-ft range. At 1200 the storm was still raging. The USNS S. P. LEE near 43°N, 138°W, was ravaged by 60-kn winds with incredible 46-ft seas and 52-ft swells. The SEA-LAND MCLEAN registered a low 947.5 mb on her barometer at 49°N, 141°W.

On the 25th the highest winds were 70 kn and the highest waves 41 ft. It was still a vicious storm. Late that day the storm started filling as it approached Sitka on the coast. By 1200 on the 26th the 983-mb center disappeared as another storm moved eastward across the Alaska Peninsula.

While Harriet was turning extratropical, Ivy was coming to life some 800 mi to the south. Ivy meandered for several days before organizing and heading northeastward. On the 24th she reached typhoon intensity near 21°N, 150°E. Ivy crossed the 25th parallel near 155°E late in the day. The following day winds climbed to 90 kn near her center, and this was her peak intensity. After this winds began to diminish and cold air began to intrude into Ivy's circulation. She started to turn extratropical.

Tropical storm Jean was a short-lived system that formed at the end of the month. First detected near 19°N, 157°E, on the 28th, Jean was moving northward. She developed rapidly and swung toward the northeast. By late on the 29th Jean was at typhoon intensity. These 65-kn winds lasted less than 24 hr as Jean fell back to tropical storm strength near 25°N, 159°E, at 1200 on the 30th. She then drifted westward for 24 hr before falling apart completely. On November 2 she attempted a comeback. Jean regenerated near 26°N, 146°E. She never got beyond tropical depression stage, and this lasted for only 1 day.

Casualties--The 19,713-ton Panamanian MARITIME ACE requested survey of heavy weather damage to shell plating at Achi Innoshima. On the 18th the Indian bulkcarrier ALEXANDRA N. returned to Victoria with heavy weather damage. The 35,545-ton

(Continued on page 126.)

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

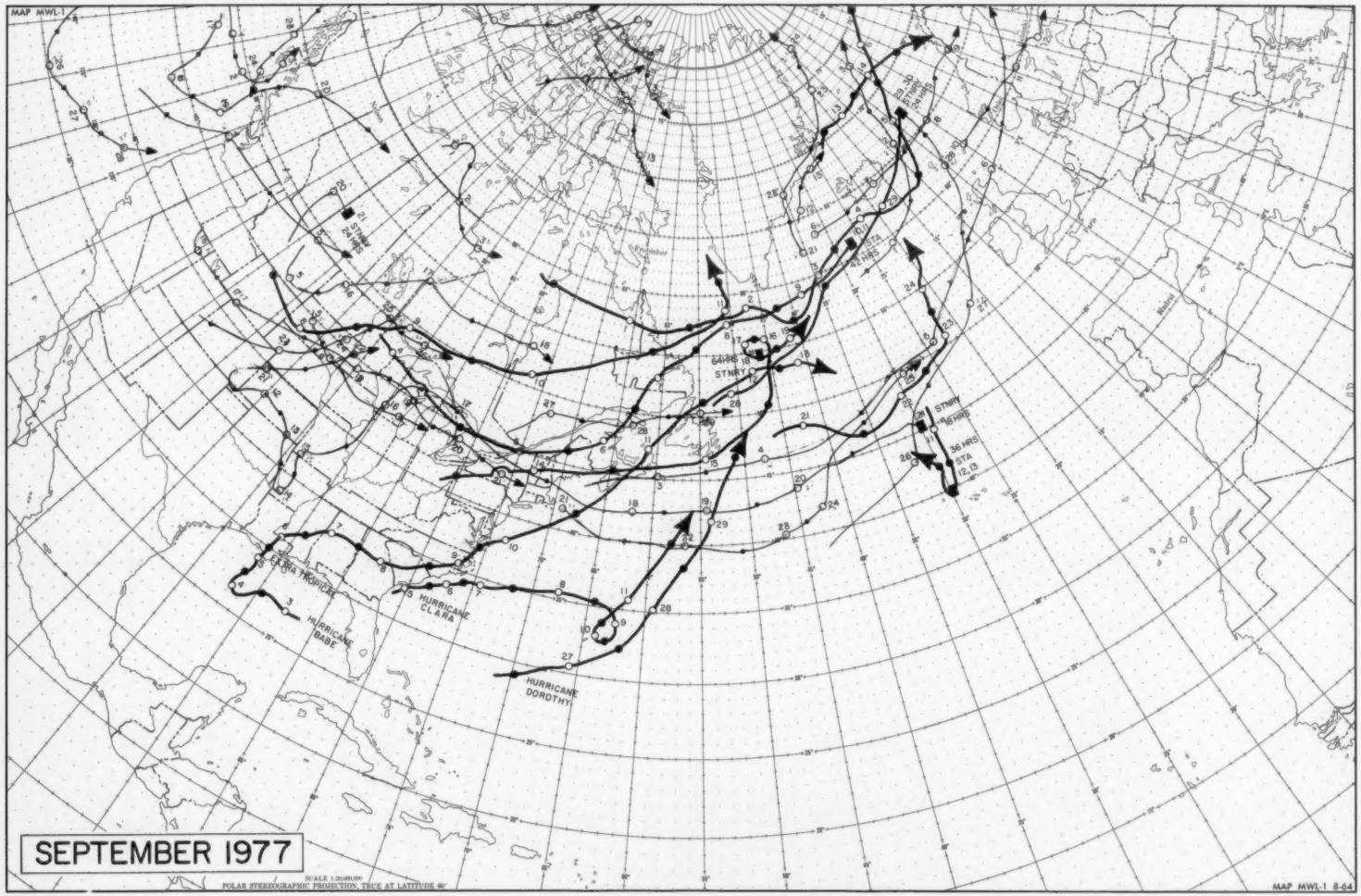


Figure 47.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

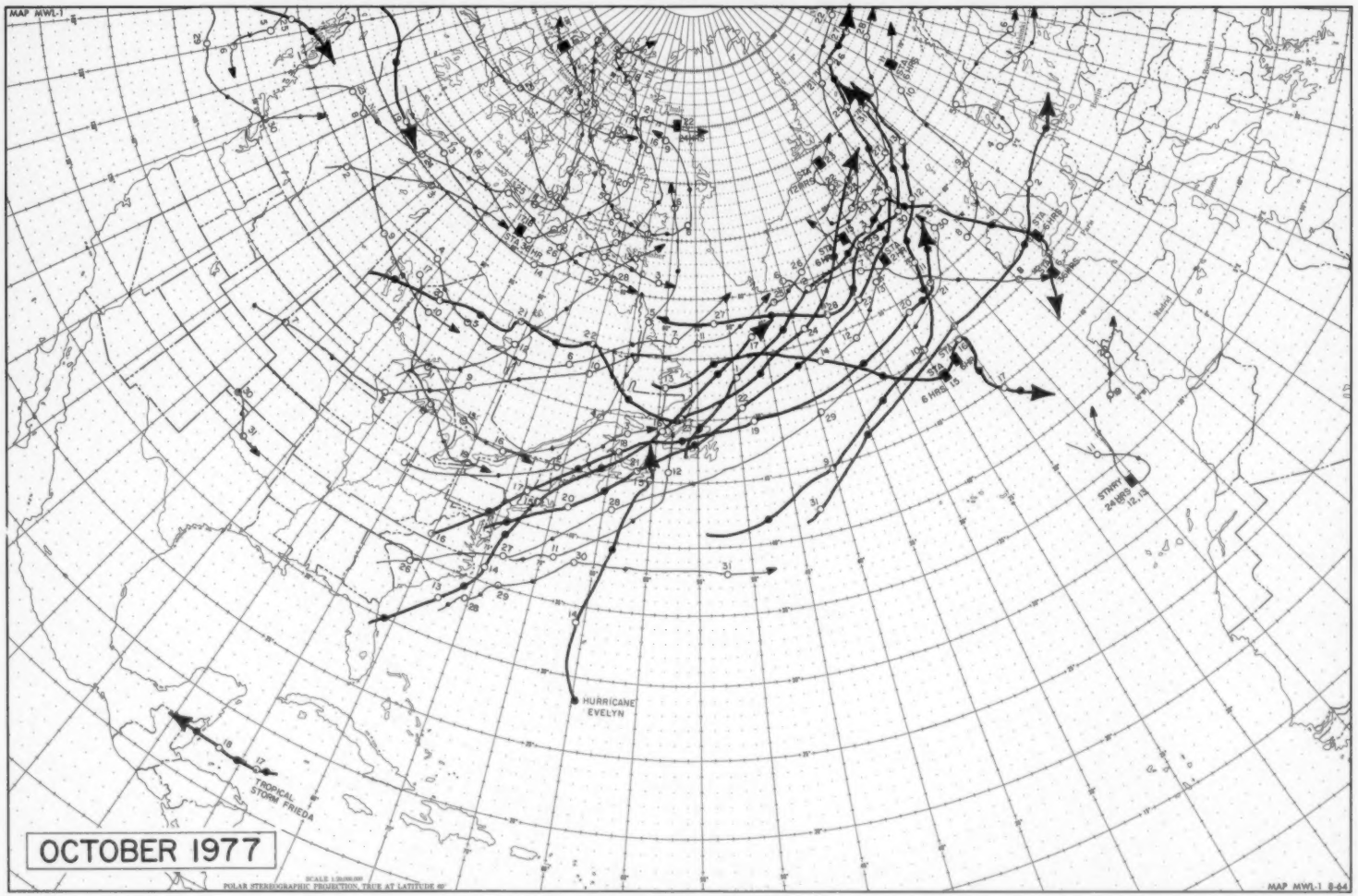


Figure 48.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

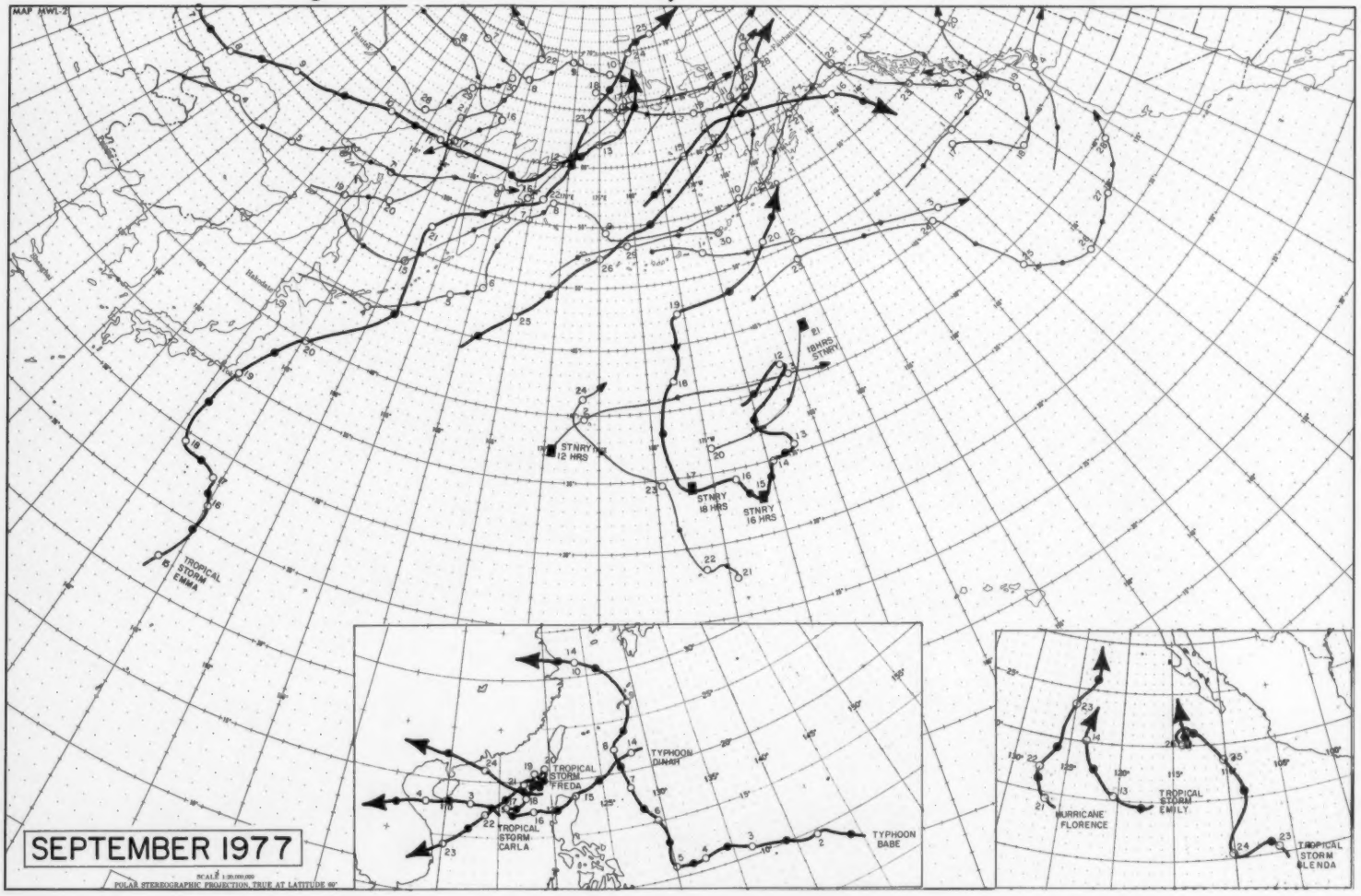


Figure 49. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

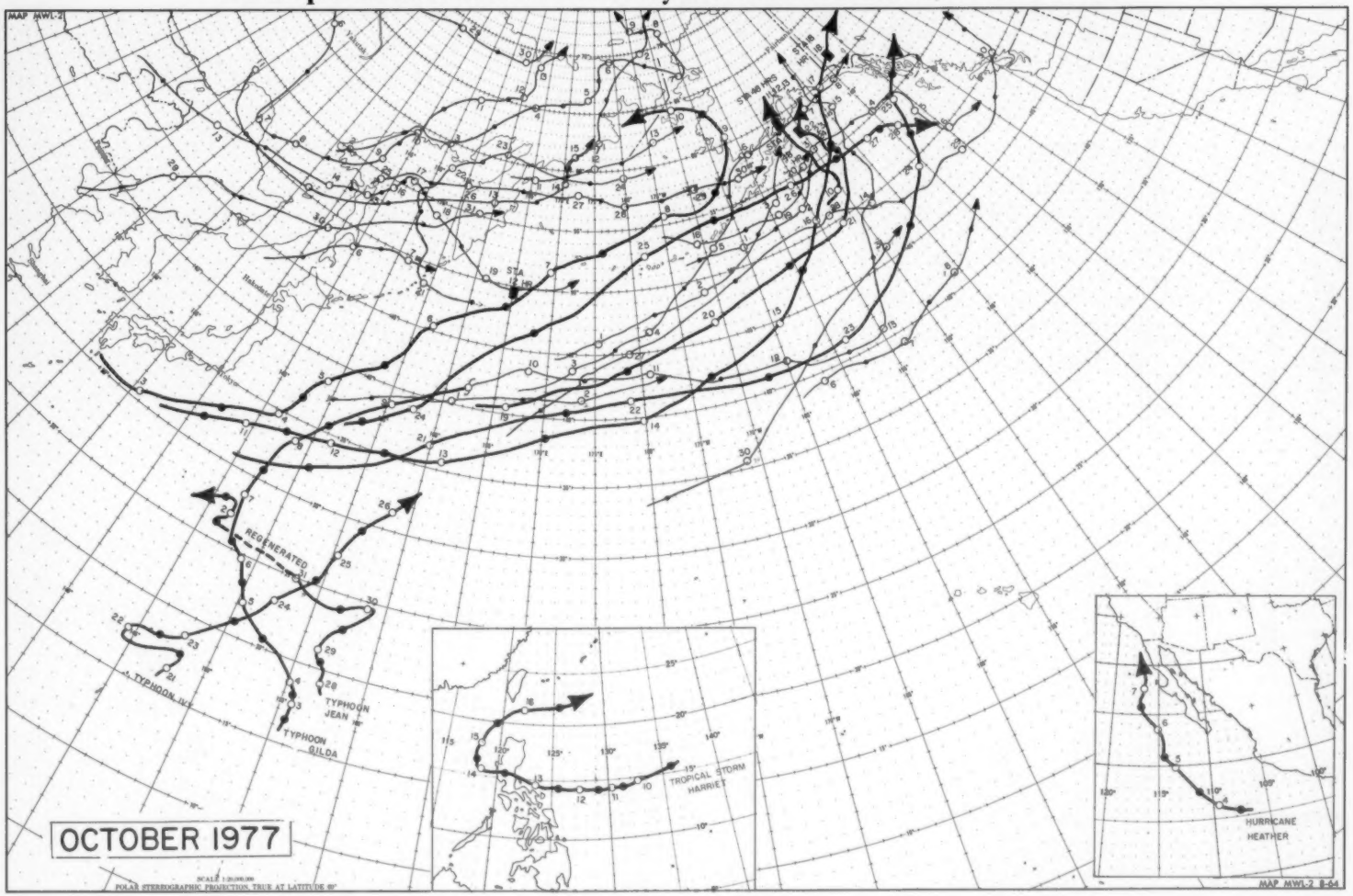
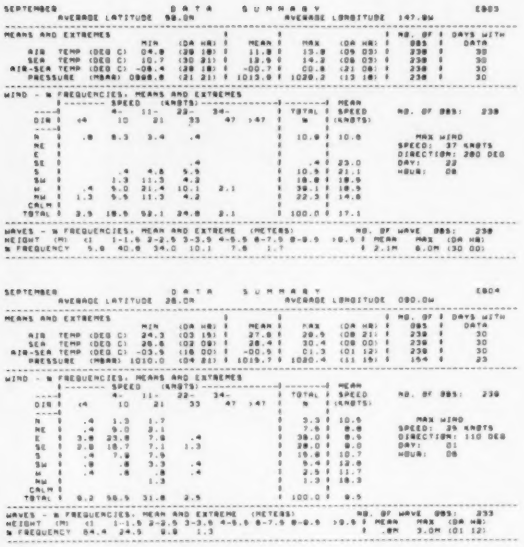


Figure 50.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 5
U.S. Ocean Buoy Climatological Data
September and October 1977



SEPTEMBER — DATA SUMMARY — EB03

AVERAGE LATITUDE 58.0N — AVERAGE LONGITUDE 147.0W

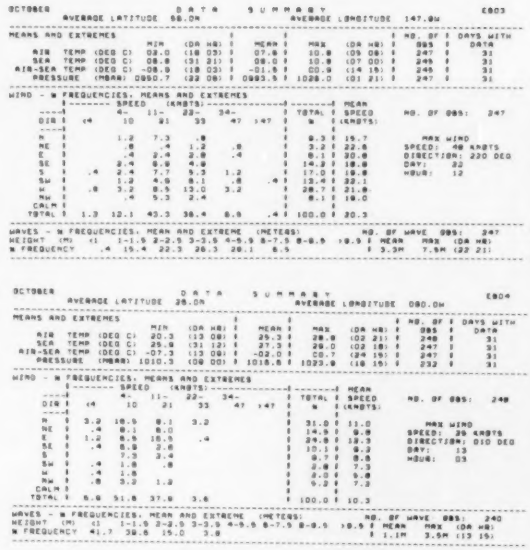
MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.8	(29 18)	11.8	15.8	(09 03)	238	30
SEA TEMP (DEG C)	10.7	(30 21)	13.9	14.2	(08 03)	238	30
AIR-SEA TEMP (DEG C)	-08.4	(29 18)	-02.7	00.8	(21 06)	238	30
PRESSURE (MBAR)	0998.8	(21 21)	1013.9	1029.2	(13 18)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 239
N	.8	8.9	9.4	.4	19.6	10.8	MAX WIND
NE							SPEED: 37 KNOTS
E							DIRECTION: 280 DEG
SE			.4		.4	23.0	DAY: 22
S		.4	4.8	5.5	10.5	21.1	HOUR: 08
SW		1.3	11.3	4.2	16.8	18.9	
W	.4	5.0	21.4	10.1	2.1	36.9	18.5
NW	1.3	9.5	11.3	4.2		22.3	14.8
CALM						1.3	
TOTAL	2.5	18.5	52.1	24.8	2.1	100.0	17.1

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	5.5	40.8	34.0	10.1	7.5	1.7			2.1M	8.0M (30 00)



OCTOBER — DATA SUMMARY — EB03

AVERAGE LATITUDE 58.0N — AVERAGE LONGITUDE 147.0W

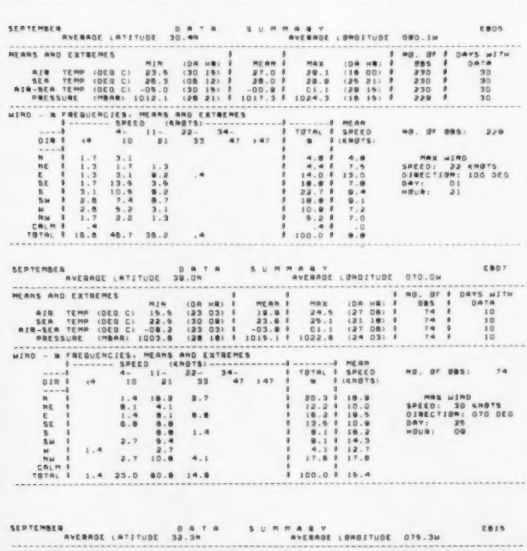
MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	02.0	(18 03)	07.6	10.8	(09 08)	247	31
SEA TEMP (DEG C)	08.8	(31 21)	08.0	10.8	(07 00)	245	31
AIR-SEA TEMP (DEG C)	-08.9	(18 03)	-01.6	00.9	(14 15)	245	31
PRESSURE (MBAR)	0990.7	(22 08)	0993.5	1028.0	(01 21)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 247
N		1.2	7.3	.8	8.3	15.7	MAX WIND
NE		.8	.4	1.2	2.8	22.8	SPEED: 48 KNOTS
E		.4	2.4	2.8	.4	6.1	30.8	DIRECTION: 220 DEG
SE		2.4	9.9	4.9		17.2	18.8	DAY: 22
S	.4	2.4	7.7	5.3	1.2	17.0	16.8	HOUR: 12
SW		1.2	4.9	8.1	.8	14.9	22.1	
W	.8	3.2	8.5	13.0	3.2	28.7	21.8	
NW		.4	5.3	2.4		8.1	19.0	
CALM						.4		
TOTAL	1.2	12.1	45.3	38.4	8.9	100.0	20.3	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	.4	15.4	22.3	26.3	20.1	6.5			3.3M	7.9M (22 21)



SEPTEMBER — DATA SUMMARY — EB04

AVERAGE LATITUDE 28.0N — AVERAGE LONGITUDE 080.0W

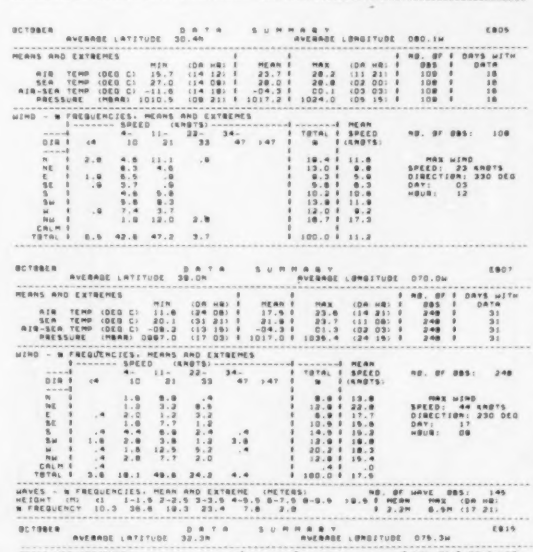
MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	24.3	(03 15)	27.0	28.9	(08 21)	239	30
SEA TEMP (DEG C)	28.6	(02 09)	28.4	30.4	(08 00)	236	30
AIR-SEA TEMP (DEG C)	-03.5	(16 00)	-00.9	01.3	(01 12)	239	30
PRESSURE (MBAR)	1010.0	(04 21)	1015.7	1020.4	(11 15)	159	25

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 239
N	.4	1.3	1.7		3.3	10.5	MAX WIND
NE	.4	9.0	2.1		11.6	13.8	SPEED: 29 KNOTS
E	3.8	23.8	7.9	.4	36.0	8.9	DIRECTION: 110 DEG
SE	2.9	18.7	7.1	1.3	28.0	9.4	DAY: 01
S	.4	7.9	7.9		16.3	10.7	HOUR: 08
SW	.8	.8	3.3	.4	5.4	12.8	
W	.4	.8	1.3	.4	2.5	11.7	
NW			1.3		1.3	18.3	
CALM					1.3		
TOTAL	8.2	56.5	31.8	2.5	100.0	9.5	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 233

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	54.4	24.5	9.9	1.3					.8M	3.0M (01 12)



OCTOBER — DATA SUMMARY — EB04

AVERAGE LATITUDE 28.0N — AVERAGE LONGITUDE 080.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	20.3	(13 08)	25.3	28.8	(02 21)	248	31
SEA TEMP (DEG C)	25.8	(31 23)	27.3	29.0	(02 18)	247	31
AIR-SEA TEMP (DEG C)	-07.3	(13 08)	-02.0	00.7	(24 19)	247	31
PRESSURE (MBAR)	1010.3	(08 00)	1018.8	1023.9	(18 15)	232	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 248
N	3.2	18.9	9.1	3.2	34.3	11.0	MAX WIND
NE	.4	5.2	3.2		8.9	9.8	SPEED: 29 KNOTS
E	1.2	8.5	16.5	.4	26.6	12.3	DIRECTION: 010 DEG
SE	.4	8.9	2.8		12.1	9.2	DAY: 13
S		1.2	7.3	.4	8.9	10.3	HOUR: 03
SW	.4	1.6	.8		2.8	7.5	
W	.4	1.6			2.0	9.0	
NW	.8	3.2	1.2		5.2	7.3	
CALM							
TOTAL	6.9	51.8	37.9	3.6	100.0	10.3	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	41.7	38.8	15.0	3.8					1.1M	3.5M (13 15)

SEPTEMBER — DATA SUMMARY — EB05

AVERAGE LATITUDE 30.4N — AVERAGE LONGITUDE 090.1W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.5	(30 15)	27.0	29.1	(16 00)	230	30
SEA TEMP (DEG C)	28.3	(08 12)	28.0	29.2	(25 21)	230	30
AIR-SEA TEMP (DEG C)	-05.0	(30 15)	-00.8	01.1	(29 15)	230	30
PRESSURE (MBAR)	1012.1	(26 21)	1017.5	1024.3	(16 15)	229	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 229
N	1.7	3.1			4.8	4.8	MAX WIND
NE	1.3	1.7	1.3		4.4	7.5	SPEED: 22 KNOTS
E	1.3	3.1	8.2	.4	13.0	DIRECTION: 100 DEG
SE	1.7	13.9	5.9		18.8	7.8	DAY: 01
S	5.1	10.5	9.2		24.7	9.4	HOUR: 21
SW	2.6	7.4	8.7		18.8	9.1	
W	2.6	5.2	3.1		10.9	7.2	
NW	1.7	2.2	1.3		5.2	7.0	
CALM	.4				.4	.0	
TOTAL	18.8	48.7	38.2	.4	100.0	8.8	

OCTOBER — DATA SUMMARY — EB05

AVERAGE LATITUDE 30.4N — AVERAGE LONGITUDE 090.1W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	15.7	(14 12)	23.7	28.2	(11 21)	109	18
SEA TEMP (DEG C)	27.0	(14 08)	28.0	29.0	(02 00)	109	18
AIR-SEA TEMP (DEG C)	-11.6	(14 18)	-04.3	00.1	(02 03)	109	18
PRESSURE (MBAR)	1010.5	(08 21)	1017.2	1024.0	(05 15)	109	18

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 109
N	2.8	4.6	11.1	.8	19.4	11.8	MAX WIND
NE		8.3	4.6		13.0	9.8	SPEED: 23 KNOTS
E	1.8	5.5	8		9.3	5.9	DIRECTION: 330 DEG
SE	.9	3.7	.9		5.5	8.3	DAY: 03
S		4.6	5.5		10.2	10.9	HOUR: 12
SW		5.5	8.3		13.8	11.9	
W	.9	7.4	3.7		12.0	9.2	
NW		3.8	12.0	2.8	18.7	17.3	
CALM							
TOTAL	6.5	42.6	47.2	3.7	100.0	11.2	

SEPTEMBER — DATA SUMMARY — EB07

AVERAGE LATITUDE 38.0N — AVERAGE LONGITUDE 070.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	15.5	(23 03)	19.8	24.5	(27 06)	74	10
SEA TEMP (DEG C)	22.5	(30 09)	23.8	25.1	(21 18)	74	10
AIR-SEA TEMP (DEG C)	-08.2	(23 03)	-03.9	01.3	(27 06)	74	10
PRESSURE (MBAR)	1003.8	(28 18)	1015.1	1022.8	(24 03)	74	10

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 74
N		1.4	18.9	8.7	29.3	16.9	MAX WIND
NE		8.1	4.1		12.2	10.0	SPEED: 30 KNOTS
E		1.4	2.7	6.8	10.8	18.5	DIRECTION: 070 DEG
SE		6.8	6.8		13.5	10.9	DAY: 25
S			8.8	1.4	10.2	16.2	HOUR: 09
SW		2.7	8.1		10.8	14.5	
W	1.4		2.7		4.1	12.7	
NW		2.7	10.8	4.1	17.6	17.8	
CALM							
TOTAL	1.4	25.0	60.8	14.8	100.0	16.4	

OCTOBER — DATA SUMMARY — EB07

AVERAGE LATITUDE 38.0N — AVERAGE LONGITUDE 070.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	11.6	(24 08)	17.5	23.6	(14 21)	248	31
SEA TEMP (DEG C)	20.1	(31 21)	21.9	23.7	(11 06)	248	31
AIR-SEA TEMP (DEG C)	-08.2	(13 15)	-04.3	01.3	(02 03)	248	31
PRESSURE (MBAR)	0987.0	(17 03)	1017.0	1036.4	(24 15)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 248
N		1.6	8.8	.4	8.8	13.8	MAX WIND
NE		1.2	3.2	8.5	12.9	22.8	SPEED: 44 KNOTS
E	.4	2.0	2.0	3.2	7.7	17.1	DIRECTION: 230 DEG
SE		1.6	7.7	1.2	10.5	15.6	DAY: 17
S	.4	4.4	8.8	2.8	.4	14.9	19.2	HOUR: 09
SW	1.6	2.8	3.6	1.2	3.6	12.9	18.8	
W	.4	1.6	12.5	5.2	.4	20.2	18.3	
NW	.4	2.8	7.7	2.0		12.9	15.4	
CALM	.4					.4	.0	
TOTAL	3.6	18.1	49.8	24.2	4.4	100.0	17.6	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 145

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	10.3	38.6	18.3	23.4	7.6	2.8			2.3M	6.9M (17 21)

SEPTEMBER — DATA SUMMARY — EB15

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 075.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	26.2	(04 15)	28.4	29.4	(17 21)	240	30
SEA TEMP (DEG C)	27.3	(30 18)	28.0	28.8	(03 21)	240	30
AIR-SEA TEMP (DEG C)	-04.5	(08 08)	-01.8	00.0	(17 21)	240	30
PRESSURE (MBAR)	1028.1	(28 21)	1031.5	1035.1	(18 15)	240	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 240
N	.4	1.3	.8	.4	2.9	12.2	MAX WIND
NE		1.3	3.3	.4	5.0	14.6	SPEED: 25 KNOTS
E	.4	7.1	14.6	.4	22.5	11.5	DIRECTIONS: 210 DEG
SE		7.9	9.2		17.1	9.2	DAY: 07
S	2.9	7.5	4.6	.4	15.8	9.3	HOUR: 00
SW	2.9	8.3	13.8	1.3	23.8	12.1	
W		3.8	8.5		12.5	12.9	
NW	.4	2.1	2.9		5.4	11.3	
CALM	1.3				1.3	.0	
TOTAL	7.9	37.9	61.7	2.9	100.0	11.2	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 240

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	33.8	65.8	.4						.8M	3.0M (07 08)

OCTOBER — DATA SUMMARY — EB15

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 075.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	15.8	(17 15)	22.5	27.0	(03 00)	247	31
SEA TEMP (DEG C)	27.1	(05 21)	28.1	27.7	(05 18)	247	31
AIR-SEA TEMP (DEG C)	-10.1	(17 15)	03.6	00.1	(26 18)	247	31
PRESSURE (MBAR)	1005.8	(14 00)	1018.7	1027.4	(24 15)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 248
N	.4	4.8	8.0	2.8	14.1	14.4	MAX WIND
NE	.4	2.8	8.9	1.2	13.3	12.5	SPEED: 33 KNOTS
E	.4	1.2	6.5	5.2	13.3	18.8	DIRECTION: 140 DEG
SE	1.2	1.2	4.8	2.8	10.1	19.1	DAY: 26
S			2.8	5.2	8.0	14.8	HOUR: 15
SW		2.0	10.9	1.6	14.5	18.9	
W	1.2	2.4	8.4	8.0	19.5	19.5	
NW	.4	.8	6.5	1.6	9.3	17.8	
CALM	1.6				1.6	.0	
TOTAL	5.0	20.2	52.4	21.4	100.0	15.7	

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 248

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-7.5	8-9.5	>9.5	MEAN	MAX (DA HR)
% FREQUENCY	14.1	47.6	30.2	8.1					1.0M	3.5M (31 21)

SEPTEMBER D A T A S U M M A R Y EB15

AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.7	(18 00)	16.4	19.5	(06 21)	238	30
PRESSURE (MBAR)	0999.2	(19 00)	1017.4	1031.3	(09 18)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 237
	<4	10	21	33	47 >47		
N							
NE		9.1	30.4	1.7		37.1	18.4
E			7.2			7.2	18.5
SE	1.7	1.7	.4			3.8	9.6
S	.8	.4				1.3	7.1
SW	.4	1.7	1.7			3.8	8.5
W		2.5	5.9			8.4	13.2
NW	1.7	5.1	5.1			11.8	9.8
CALM	.8	6.3	19.0			26.2	12.8
TOTAL	.4					.4	7.0
	5.9	22.8	89.9	1.7		100.0	13.3

MAX WIND
SPEED: 23 KNOTS
DIRECTION: 300 DEG
DAY: 12
HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	5.5	56.3	30.1	2.1					1.6M	3.0M	(25 06)

SEPTEMBER D A T A S U M M A R Y EB17

AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	09.3	(23 15)	11.8	13.3	(02 00)	239	30
SEA TEMP (DEG C)	11.5	(30 21)	12.1	12.9	(29 03)	238	30
AIR-SEA TEMP (DEG C)	-02.6	(23 15)	-00.3	01.0	(25 21)	238	30
PRESSURE (MBAR)	0998.0	(20 15)	1018.2	1030.8	(14 06)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 230
	<4	10	21	33	47 >47		
N							
NE	.8	.8	3.8			5.4	11.8
E		1.7	1.7			3.3	9.9
SE	.4	1.3	1.7			3.3	10.3
S	1.3	.4	4.8			6.6	12.4
SW		3.8	8.7	3.8		16.2	16.8
W		9.0	16.9	4.2		14.2	16.9
NW		1.7	14.2	9.0		26.1	17.1
CALM	.4	2.1	14.8	3.8		30.9	18.0
TOTAL	2.9					2.9	9.0
	5.4	18.0	66.8	16.7		100.0	14.7

MAX WIND
SPEED: 31 KNOTS
DIRECTION: 290 DEG
DAY: 15
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	3.4	56.3	30.7	8.8	.8				1.7M	4.0M	(18 19)

SEPTEMBER D A T A S U M M A R Y EB19

AVERAGE LATITUDE 51.0N AVERAGE LONGITUDE 138.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.5	(23 03)	13.2	15.5	(11 03)	240	30
SEA TEMP (DEG C)	12.7	(30 15)	13.8	14.5	(14 00)	240	30
AIR-SEA TEMP (DEG C)	-03.1	(23 03)	-00.7	00.7	(22 03)	240	30
PRESSURE (MBAR)	0998.1	(17 09)	1017.4	1030.8	(11 21)	240	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 240
	<4	10	21	33	47 >47		
N							
NE		1.3	14.2			15.4	14.5
E		.8	1.7	.8		3.3	15.8
SE		.8	3.8	.4		5.0	16.2
S		1.7	2.9	.8		5.4	15.0
SW		1.7	2.9	.4		4.6	12.0
W	.4	5.0	7.1	.8		13.3	12.6
NW	.4	12.9	15.7	3.8		33.0	12.2
CALM	1.3	3.8	14.6	1.7		21.3	14.3
TOTAL	.4					.4	7.0
	2.9	30.7	62.9	8.3		100.0	13.8

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 270 DEG
DAY: 23
HOUR: 00

SEPTEMBER D A T A S U M M A R Y EB20

AVERAGE LATITUDE 41.1N AVERAGE LONGITUDE 137.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	14.7	(28 15)	18.1	20.6	(04 15)	239	30
PRESSURE (MBAR)	1002.2	(18 03)	1021.3	1032.3	(21 21)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 239
	<4	10	21	33	47 >47		
N							
NE		2.1	10.9	.4		13.4	15.8
E	.4	2.5	12.1	5.9		20.9	17.3
SE		1.7	8.5			10.3	15.9
S		1.7	8.8			10.5	15.2
SW		2.1	.4			2.5	7.0
W		2.5	2.9			5.4	11.0
NW		7.9	7.1	2.1		17.2	12.7
CALM		4.2	13.8	3.8		21.8	16.3
TOTAL	.4					.4	7.0
	.8	24.7	82.3	12.1		100.0	14.7

MAX WIND
SPEED: 39 KNOTS
DIRECTION: 060 DEG
DAY: 06
HOUR: 16

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 239

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	.8	81.5	28.4	11.5					1.7M	3.5M	(27 09)

SEPTEMBER D A T A S U M M A R Y EB34

AVERAGE LATITUDE 40.1N AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.2	(18 00)	21.3	24.1	(04 03)	129	18
SEA TEMP (DEG C)	19.1	(18 06)	21.8	23.8	(08 18)	129	18
AIR-SEA TEMP (DEG C)	-03.9	(12 06)	-00.6	01.8	(14 15)	129	18
PRESSURE (MBAR)	1006.5	(10 21)	1018.5	1031.5	(16 06)	125	18

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 124
	<4	10	21	33	47 >47		
N							
NE		.8	8.5			7.3	19.8
E		2.4	6.7			12.1	12.7
SE		8.8	12.1			21.0	11.9
S	1.6	4.8	.8			7.3	10.6
SW		9.7	8.9			18.9	10.9
W	.8	8.8	6.5	1.6		17.7	10.9
NW		2.4	.8			3.2	10.1
CALM		3.2	8.1	1.6		12.9	14.0
TOTAL							
	2.4	41.1	53.2	3.3		100.0	11.7

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 320 DEG
DAY: 14
HOUR: 15

SEPTEMBER D A T A S U M M A R Y EB41

AVERAGE LATITUDE 38.7N AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	19.4	(28 15)	21.9	25.3	(01 15)	238	30
SEA TEMP (DEG C)	19.8	(30 12)	22.1	24.8	(01 21)	238	30
AIR-SEA TEMP (DEG C)	-04.3	(28 15)	-00.6	01.9	(27 09)	238	30
PRESSURE (MBAR)	1009.8	(28 06)	1017.0	1030.5	(16 06)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 235
	<4	10	21	33	47 >47		
N							
NE	.4	2.6	6.4			9.1	10.9
E	.4	4.3	8.5			13.2	11.9
SE	.4	5.1	5.1			10.6	10.6
S	.4	9.9	7.2			17.4	9.9
SW	.9	10.6	4.7			16.2	9.0
W		13.3	13.2	.4		26.8	11.3
NW	.9	8.5	6.4			15.8	9.4
CALM	.4	2.6	7.7			10.6	12.7
TOTAL							
	3.8	48.9	46.8	.4		100.0	10.8

MAX WIND
SPEED: 22 KNOTS
DIRECTION: 210 DEG
DAY: 14
HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 239

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	10.9	74.8	13.4	.8					1.2M	3.0M	(10 03)

OCTOBER D A T A S U M M A R Y EB15

AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	11.1	(27 18)	15.9	18.2	(22 21)	245	31
PRESSURE (MBAR)	1000.0	(28 00)	1018.9	1030.9	(18 18)	245	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 245
	<4	10	21	33	47 >47		
N							
NE	1.2	4.9	20.0			26.1	19.0
E		1.2	2.0			3.3	16.6
SE	.4		2.0			2.4	10.0
S			1.6			2.0	11.8
SW	.8	3.7	1.6	0.8	.4	17.8	17.4
W	1.6	4.1	5.7	2.0		13.9	12.8
NW	1.2	6.5	11.8	4.5		24.5	14.2
CALM	.8	4.1	4.5	.8		10.2	11.4
TOTAL	1.6					1.6	.0
	7.8	24.9	53.9	13.1	.4	100.0	13.8

MAX WIND
SPEED: 34 KNOTS
DIRECTION: 190 DEG
DAY: 24
HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 245

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	1.2	31.8	28.2	13.9	19.9	5.1			2.2M	7.0M	(25 12)

OCTOBER D A T A S U M M A R Y EB17

AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	02.3	(22 12)	07.6	11.7	(01 12)	247	31
SEA TEMP (DEG C)	10.5	(22 12)	11.7	12.8	(02 03)	247	31
AIR-SEA TEMP (DEG C)	-05.6	(22 12)	-01.4	02.7	(26 00)	247	31
PRESSURE (MBAR)	0942.5	(28 15)	0997.8	1023.8	(09 03)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 247
	<4	10	21	33	47 >47		
N							
NE		1.6	3.6	2.8		8.1	17.8
E	.4		1.2	.4		2.4	12.2
SE		.8	2.4	.8		4.0	17.4
S	.8		3.2	.8		4.9	15.8
SW	.8	2.8	4.5	2.4	.8	10.1	17.8
W		.8	4.9	3.6	1.6	10.9	22.3
NW		3.2	10.9	10.9	1.6	26.7	22.3
CALM		2.0	3.2	10.5	4.0	19.8	20.0
TOTAL	.4					.4	.0
	2.4	10.5	37.7	41.3	8.1	100.0	21.3

MAX WIND
SPEED: 31 KNOTS
DIRECTION: 310 DEG
DAY: 27
HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 246

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	19.4	20.3	32.9	24.0	4.1	3.3			1.3M	6.6M	(27 15)

OCTOBER D A T A S U M M A R Y EB19

AVERAGE LATITUDE 51.0N AVERAGE LONGITUDE 138.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.1	(23 15)	11.7	14.3	(11 03)	189	25
SEA TEMP (DEG C)	10.8	(25 03)	12.0	13.5	(01 06)	190	25
AIR-SEA TEMP (DEG C)	-03.8	(23 15)	-00.3	02.4	(21 21)	189	25
PRESSURE (MBAR)	0997.5	(24 18)	1015.4	1031.5	(02 06)	190	25

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 190
	<4	10	21	33	47 >47		
N							
NE							
E	.5					1.0	19.5
SE		1.6		1.1		2.6	20.4
S	.5		1.6	0.5	0.5	3.2	27.0
SW	.5	2.1	8.4	14.2	1.6	28.4	21.5
W	.5	1.1	14.7	10.0	1.1	.5	27.0
NW	.5	5.3	12.6	8.9		27.4	20.0
CALM		1.1	2.6	.5		4.2	19.6
TOTAL	1.1					1.1	13.0
	3.7	11.1	40.0	36.6	5.8	100.0	20.0

MAX WIND
SPEED: 49 KNOTS
DIRECTION: 220 DEG
DAY: 25
HOUR: 00

OCTOBER D A T A S U M M A R Y EB20

AVERAGE LATITUDE 41.1N AVERAGE LONGITUDE 137.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.3	(25 15)	15.5	19.4	(21 18)	247	31
PRESSURE (MBAR)	1003.3	(18 15)	1018.3	1032.7	(16 06)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 246
	<4	10	21	33	47 >47		
N							
NE	1.2	2.0	.8			4.1	7.2
E		1.6	.8			2.4	9.8
SE	.4	2.4	2.4			5.3	9.1
S	.8	3.3	3.3			7.4	8.5
SW	.8	4.1	10.2	7.3	.4	22.8	18.5
W	.4	2.0	11.0	4.9	.8	19.1	17.4
NW	.4	8.5	9.3	3.2	1.2	32.5	17.8
CALM	.4	2.0	6.9	2.0		11.0	15.3
TOTAL	.4					.4	.0
	4.5	25.8	43.9	25.8	2.4	100.0	14.7

MAX WIND
SPEED: 29 KNOTS
DIRECTION: 320 DEG
DAY: 24
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	3.2	27.9	23.1	14.6	22.7	9.1	.4		2.0M	6.0M	(25 00)

OCTOBER D A T A S U M M A R Y EB34

AVERAGE LATITUDE 40.1N AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	15.8	(28 15)	19.4	22.8	(28 18)	95	12
SEA TEMP (DEG C)	15.3	(31 18)	19.8	24.7	(28 18)	95	12
AIR-SEA TEMP (DEG C)	-04.0	(25 18)	-00.4	01.5	(25 03)	95	12
PRESSURE (MBAR)	1007.3	(30 09)	1022.4	1036.4	(26 15)	95	12

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 93
	<4	10	21	33	47 >47		
N							
NE	1.1	4.3	5.4			10.8	11.2
E		5.5	14.0	8.6		28.0	17.0
SE	2.2	4.3	3.2			9.7	8.6
S		6.5				6.5	6.1
SW	1.1	6.5	1.1			8.6	7.0
W		9.4	4.8			14.0	11.7
NW	2.2	3.2	6.5			11.8	8.9
CALM		1.1	8.5	1.1		10.8	10.1
TOTAL							
	8.6	37.8	48.2	10.8		100.0	12.0

MAX WIND
SPEED: 29 KNOTS
DIRECTION: 320 DEG
DAY: 21
HOUR: 00

OCTOBER D A T A S U M M A R Y EB41

AVERAGE LATITUDE 38.7N AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.8	(17 12)	14.7	21.8	(02 06)	248	31
SEA TEMP (DEG C)	13.1	(31 21)	15.8	20.0	(02 06)	249	31
AIR-SEA TEMP (DEG C)	-09.2	(03 15)	-00.9	03.8	(28 18)	249	31
PRESSURE (MBAR)	0999.8	(17 03)	1016.8	1034.8	(24 15)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) 4-	11-	22-	34-	TOTAL %	MEAN SPEED (KNOTS)	NO. OF OBS: 248
	<4	10	21	33	47 >47		
N							
NE	1.2	1.8	4.5	2.0		9.3	14.2
E	.4	5.3	13.3	.4		19.8	15.0
SE	1.6	5.3	1.8			8.5	7.6
S		4.1	3.3			7.3	10.1
SW	.4	4.9	5.3	.4		11.0	11.3
W		8.0	7.7	1.2		16.9	13.7
NW	.8	4.1	8.1	4.1		17.0	13.2
CALM	.4	2.8	13.0	3.6		19.9	15.4
TOTAL						.4	.0
	3.7	38.0	56.9	11.0		100.0	13.9

MAX WIND
SPEED: 31 KNOTS
DIRECTION: 270 DEG
DAY: 17
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	17.0	49.3	22.7	10.1	4.0				1.6M	5.0M	(17 09)

SEPTEMBER DATA SUMMARY E844
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 086.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	24.3	(04 19)	28.0	30.1	(24 21)	235	30
SEA TEMP (DEG C)	28.0	(04 15)	28.7	30.4	(25 21)	233	30
AIR-SEA TEMP (DEG C)	-02.7	(18 03)	-00.7	00.9	(07 21)	233	30
PRESSURE (MBAR)	1009.4	(03 09)	1015.2	1018.8	(17 03)	234	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 234
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	4.3	3.0	.9				8.1	4.7
NE	9.1	11.9	5.4				26.1	8.4
E	5.0	23.1	4.7				34.8	8.8
SE	3.4	9.8	7.3				18.2	8.4
S	1.3	5.6	1.3				8.1	7.4
SW		.9	.9				1.7	10.8
W	.9						.9	3.1
NW	2.6	.9					3.5	5.1
CALM	.9						.9	.0
TOTAL	25.2	50.4	24.4				100.0	7.2

MAX WIND
SPEED: 18 KNOTS
DIRECTION: 100 DEG
DAY: 01
HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 215

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6-7.5	8-8.5	>8.5	MEAN	MAX (DA HR)
% FREQUENCY	77.7	20.5	1.9							.6M	2.0M (02 21)

OCTOBER DATA SUMMARY E844
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 086.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	20.5	(13 21)	25.1	29.0	(02 21)	244	31
SEA TEMP (DEG C)	25.0	(29 08)	25.9	30.4	(02 21)	244	31
AIR-SEA TEMP (DEG C)	-07.1	(13 21)	-01.8	01.0	(24 16)	244	31
PRESSURE (MBAR)	1011.8	(08 21)	1018.8	1022.0	(19 15)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 244
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	2.5	11.9	10.7				25.0	8.8
NE	2.0	8.1	7.4				19.8	9.1
E	.4	7.4	15.4				24.2	11.3
SE	.8	7.8	3.3				11.1	8.0
S	2.0	2.8					4.9	5.4
SW	1.5	2.8					4.6	4.8
W	2.0	2.9	.8				5.7	5.9
NW	2.9	4.8	1.8				9.5	6.5
CALM	.4						.4	.0
TOTAL	14.3	48.5	40.2				100.0	8.8

MAX WIND
SPEED: 31 KNOTS
DIRECTION: 380 DEG
DAY: 13
HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 239

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6-7.5	8-8.5	>8.5	MEAN	MAX (DA HR)
% FREQUENCY	90.4	37.8	10.9	1.3						1.0M	3.0M (13 18)

SEPTEMBER DATA SUMMARY E845
AVERAGE LATITUDE 80.2N AVERAGE LONGITUDE 148.8W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.1	(28 18)	10.6	13.3	(20 03)	77	15
SEA TEMP (DEG C)	11.3	(29 18)	12.1	12.9	(10 08)	75	15
AIR-SEA TEMP (DEG C)	-04.3	(29 18)	-01.2	01.3	(23 12)	75	15
PRESSURE (MBAR)	0991.1	(29 12)	1007.2	1020.4	(29 18)	75	15

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 75
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	2.7	2.7	5.3				10.7	10.4
NE	4.0	2.7					6.7	4.2
E		2.3	12.0	1.3			22.7	13.8
SE	2.7	4.0	2.7				9.3	8.3
S	2.7	1.3	8.0				12.0	8.5
SW	1.3						1.3	2.0
W	1.3		1.3				2.7	9.8
NW	2.7	14.7	18.0				33.3	10.2
CALM	1.3						1.3	.0
TOTAL	19.7	34.7	46.5	1.3			100.0	9.0

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 080 DEG
DAY: 28
HOUR: 12

OCTOBER DATA SUMMARY E845
AVERAGE LATITUDE 80.2N AVERAGE LONGITUDE 148.8W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.6	(18 19)	07.4	10.8	(11 21)	223	31
SEA TEMP (DEG C)	07.4	(31 19)	11.8	08 08)		218	31
AIR-SEA TEMP (DEG C)	-09.4	(18 19)	-02.7	00.2	(18 00)	218	31
PRESSURE (MBAR)	0981.1	(22 15)	0997.0	1028.4	(02 09)	221	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 218
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	.5	5.5	1.8				9.1	7.7
NE	2.3	3.7	3.7	1.4			11.1	11.4
E	.9	9.1	30.6	14.4			55.0	17.8
SE	.5	.9	9.2	.5			11.1	14.0
S		3.2	6.5	.5			10.2	13.7
SW	.9		.9				2.8	8.3
W			.5				.5	5.1
NW		1.4	2.8				4.2	11.7
CALM								
TOTAL	5.5	23.2	55.5	16.7			100.0	14.8

MAX WIND
SPEED: 32 KNOTS
DIRECTION: 090 DEG
DAY: 22
HOUR: 12

SEPTEMBER DATA SUMMARY E883
AVERAGE LATITUDE 40.8N AVERAGE LONGITUDE 088.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.1	(23 00)	15.0	21.2	(27 03)	222	30
SEA TEMP (DEG C)	13.7	(01 03)	14.9	17.0	(01 21)	221	30
AIR-SEA TEMP (DEG C)	-02.7	(22 18)	01.0	06.0	(27 08)	220	30
PRESSURE (MBAR)	1003.4	(28 21)	1018.8	1032.3	(16 12)	220	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 219
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	2.3	8.8	2.7	1.8			15.4	9.5
NE	.9	9.6	7.3	1.4			19.2	11.5
E	1.8	7.3	3.2				12.3	9.4
SE	.5	1.4	.9				2.7	8.0
S	3.2	6.4	4.1				13.7	9.0
SW	.9	7.3	3.2				11.4	9.8
W	1.4	8.9	4.6				12.3	9.7
NW	1.4	2.7	8.8	.9			13.8	11.2
CALM								
TOTAL	12.3	50.7	32.8	4.1			100.0	9.9

MAX WIND
SPEED: 25 KNOTS
DIRECTION: 050 DEG
DAY: 25
HOUR: 08

OCTOBER DATA SUMMARY E883
AVERAGE LATITUDE 40.8N AVERAGE LONGITUDE 088.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	09.2	(31 21)	14.2	19.9	(02 08)	191	26
SEA TEMP (DEG C)	12.4	(31 18)	14.7	15.8	(03 08)	192	26
AIR-SEA TEMP (DEG C)	-05.2	(23 18)	-00.5	04.8	(14 18)	191	26
PRESSURE (MBAR)	0983.2	(17 06)	1017.3	1034.5	(24 15)	191	26

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 123
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	.8	1.8	4.9				7.3	11.4
NE		4.1	9.7	4.1			19.9	13.3
E	.8	4.9	2.4				13.0	11.1
SE	1.6	4.9	5.5				13.0	10.2
S		4.9	3.3				8.1	10.7
SW	.8	8.9	1.6	2.4			13.8	11.8
W	1.6	4.1	18.7	.8			25.2	12.6
NW		2.4	4.9				7.3	12.7
CALM								
TOTAL	5.7	33.3	53.7	7.3			100.0	12.3

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 080 DEG
DAY: 14
HOUR: 12

SEPTEMBER DATA SUMMARY E871
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 093.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	24.1	(04 12)	27.9	29.8	(10 00)	238	30
SEA TEMP (DEG C)	25.7	(03 08)	28.8	31.3	(26 00)	235	30
AIR-SEA TEMP (DEG C)	-03.8	(21 00)	-00.8	00.8	(03 00)	235	30
PRESSURE (MBAR)	0987.8	(01 08)	1013.3	1018.0	(01 15)	236	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 238
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	.4	2.5	.4		.4		3.8	10.8
NE	.4	2.1	2.1			.4	5.1	9.7
E	.4	10.9	3.8	2.5	.8	.4	29.0	13.8
SE	1.7	20.2	12.3	1.3			35.3	10.6
S	1.7	7.6	8.1				17.4	8.4
SW	.4	1.3	2.1				3.8	9.0
W		1.3	2.5	1.3			5.1	17.5
NW	.8	2.1	1.3				4.2	9.3
CALM								
TOTAL	5.8	54.2	32.8	3.8	2.5	.8	100.0	11.3

MAX WIND
SPEED: 55 KNOTS
DIRECTION: 100 DEG
DAY: 01
HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 239

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6-7.5	8-8.5	>8.5	MEAN	MAX (DA HR)
% FREQUENCY	57.4	31.5	8.0	1.3	3.0	.8				1.0M	6.5M (01 06)

OCTOBER DATA SUMMARY E871
AVERAGE LATITUDE 28.0N AVERAGE LONGITUDE 093.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	20.7	(13 12)	25.8	28.4	(01 21)	248	31
SEA TEMP (DEG C)	25.7	(31 12)	28.1	29.7	(02 21)	248	31
AIR-SEA TEMP (DEG C)	-07.3	(13 12)	-02.3	00.1	(01 21)	248	31
PRESSURE (MBAR)	1008.8	(00 00)	1018.5	1024.7	(13 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 247
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	.8	11.3	5.7	3.6			21.5	11.8
NE	.4	4.2	5.3	.4			20.2	9.9
E	3.2	10.1	8.5	.8			22.7	10.1
SE	1.2	6.7	10.5				17.4	11.7
S	.8	5.3	4.9				10.9	9.7
SW	.4	1.2					1.6	8.5
W	.4	1.2					1.6	4.8
NW		3.6	.4				3.2	8.8
CALM	.4						.4	.0
TOTAL	7.7	51.9	35.8	4.9			100.0	10.9

MAX WIND
SPEED: 31 KNOTS
DIRECTION: 010 DEG
DAY: 12
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6-7.5	8-8.5	>8.5	MEAN	MAX (DA HR)
% FREQUENCY	39.3	49.0	8.1	3.2	.4					1.1M	4.6M (12 21)

SEPTEMBER DATA SUMMARY E872
AVERAGE LATITUDE 57.1N AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.7	(29 19)	10.8	13.8	(01 21)	227	30
SEA TEMP (DEG C)	08.4	(30 18)	10.8	13.1	(04 00)	227	30
AIR-SEA TEMP (DEG C)	-04.9	(29 19)	00.0	02.4	(17 00)	227	30
PRESSURE (MBAR)	0983.1	(21 18)	1012.0	1028.3	(13 19)	227	30

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 226
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	.4	2.7	4.0				7.1	10.4
NE	.4	1.3					1.8	8.5
E		.4					.4	5.0
SE	.4		2.2	.9			3.5	17.4
S	1.3	8.0	15.5	3.5			28.3	14.1
SW	1.8	11.9	10.1	2.7			26.5	12.6
W	1.8	8.5	7.5	.4			18.3	10.4
NW	1.3	2.7	2.2				6.3	8.1
CALM	.9						.9	.0
TOTAL	8.5	35.2	47.8	7.5			100.0	12.1

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 220 DEG
DAY: 22
HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 213

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6-7.5	8-8.5	>8.5	MEAN	MAX (DA HR)
% FREQUENCY	21.1	49.1	21.0	2.8						1.4M	3.0M (29 18)

OCTOBER DATA SUMMARY E872
AVERAGE LATITUDE 57.1N AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	00.8	(18 03)	08.7	12.1	(02 18)	241	31
SEA TEMP (DEG C)	08.8	(28 15)	08.9	10.0	(02 00)	241	31
AIR-SEA TEMP (DEG C)	-07.6	(18 03)	-01.0	02.8	(08 12)	241	31
PRESSURE (MBAR)	0983.0	(22 03)	0993.2	1024.7	(01 21)	241	31

WIND - % FREQUENCIES, MEANS AND EXTREMES

SPEED (KNOTS)						TOTAL	MEAN SPEED	NO. OF OBS: 240
DIR	<4	4-10	11-21	22-33	34-47	>47	%	(KNOTS)
N	.4	2.9	19.0	2.9			25.4	17.0
NE	.4	1.7	4.2	2.5	.4		9.2	18.4
E		5.4	4.6	2.5			12.5	15.9
SE		2.5	5.3	5.0			10.8	19.3
S		2.1	4.2	.8			7.1	13.8
SW	.4	4.2	10.8	1.3			16.7	14.0
W	1.3	2.9	10.4	.8			15.4	13.2
NW	.4	1.3	4.6	1.7			7.9	15.7
CALM								
TOTAL	2.9	22.9	57.1	17.1	.4		100.0	15.4

MAX WIND
SPEED: 34 KNOTS
DIRECTION: 030 DEG
DAY: 22
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 227

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-4.5	5-5.5	6-7.5	8-8.5	>8.5	MEAN	MAX (DA HR)
% FREQUENCY	2.6	20.7	38.2	24.7	12.8					2.5M	5.5M (22 08)

(Continued on next page.)

Table 6

Selected Gale and Wave Observations, North Atlantic

September and October 1977

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C. Air	Temperature °C. Sea	Sea Waves+ Period sec.	Sea Waves+ Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH ATLANTIC OCEAN		SEP.															
DAVID P REYNOLDS	LIBERIAN	1	27.5 N	94.9 W	13	08	45	10 NM	02	1008.2	28.8	29.4	5	11.5	10	9	16.5
SEALAND PRODUCER	AMERICAN	16	49.0 N	40.2 W	00	19	38	5 NM	02	995.9	17.8	12.8	4	10	19	>13	14.5
HERMIA	DANISH	24	48.1 N	19.5 W	06	29	M 42	10 NM	02	1000.5	15.0	16.0	8	13			
MARSHFIELD	AMERICAN	27	46.8 N	21.1 W	12	28	M 45	5 NM	02	1009.5	18.7	17.8	8	16.5	27	12	14.5
ULYSSES	AMERICAN	28	35.9 N	05.6 W	12	11	55	2 NM	02	1020.7	23.3	17.7	6	11.5			
AMER LEGEND	AMERICAN	29	43.2 N	47.5 W	18	17	M 48	5 NM	02	1009.5	21.3	18.0	5	13	17	6	24.5
GREAT LAKES VESSELS																	
CHARLES M BEEGHLY	AMERICAN	9	47.4 N	88.9 W	18	21	M 36	> 25 NM	02		10.0	10.0	5	14.5			
C H HUMPHREY	AMERICAN	24	43.9 N	85.3 W	12	11	M 44	> 25 NM	02		12.0	17.0	5	6.5			
JOHN DYKSTRA	AMERICAN	24	43.5 N	86.5 W	18	12	M 42	2 NM	69		13.0	17.0	12	10			
C H HUMPHREY	AMERICAN	25	43.1 N	82.2 W	00	10	M 42	5 NM	69		11.0	16.0	9	13			
NORTH ATLANTIC OCEAN		SEP.															
ENVIRONMENTAL BUOYS																	
EB 71	AMERICAN	1	26.0 N	93.5 W	05	06	M 72			982.3	25.4	28.8					
EB 71	AMERICAN	1	26.0 N	93.5 W	06	10	M 66			987.8	25.3	28.4	3	21			
NORTH ATLANTIC OCEAN		OCT.															
LASH ITALIA	AMERICAN	6	38.9 N	15.8 W	12	34	45	10 NM	02	1011.3	18.9	17.3	7	13	34	9	18
AMER LEGEND	AMERICAN	10	44.6 N	26.2 W	18	30	M 48	2 NM	18	1000.6	17.2	17.8	14	24.5	33	9	19.5
MONTICELLO VICTORY	AMERICAN	13	30.4 N	79.5 W	12	32	45	5 NM	03	1011.5	21.5	28.4	7	10			
SANTA BARBARA	AMERICAN	14	35.9 N	74.2 W	06	35	50	5 NM	29	1000.7	19.4	26.7	XX	16.5	XX	X	19.5
HERMIA	DANISH	15	51.1 N	21.6 W	12	12	M 48	5 NM	02	976.5	14.0	13.0	8	11.5	17	9	16.5
IRISH STAR	IRISH	13	40.7 N	27.7 W	06	30	50	5 NM	01	996.0	18.0	18.0			19.5	30	X	36
PENSTEFL	LIBERIAN	13	42.6 N	22.4 W	12	23	M 48	5 NM	03	988.5	19.0	19.0	11	32.5	23	9	46
PENSTEFL	LIBERIAN	16	41.6 N	19.3 W	12	23	M 41	10 NM	03	990.2	23.0	18.0	10	29.5	23	9	36
AMER TRADER	AMERICAN	17	35.5 N	70.8 W	06	27	30	10 NM	07	1007.0	17.8	23.3	10	19.5	27	>13	36
BALTIMORE TRADER	AMERICAN	17	37.2 N	69.6 W	18	25	48	5 NM	02	1006.2	16.7	23.6	5	10	21	8	24.5
MORIL POWER	AMERICAN	17	40.2 N	99.0 W	18	22	45	5 NM	13	999.3	12.8	18.3	4	6.5	22	8	10.5
BALTIMORE TRADER	AMERICAN	18	36.3 N	70.1 W	00	26	48	5 NM	02	1010.8	17.8	23.6	5	8	23	8	24.5
MORIL POWER	AMERICAN	18	39.8 N	99.1 W	00	25	45	5 NM	13	1003.0	12.8	20.0	6	8	23	8	10.5
AMER LEGEND	AMERICAN	22	43.2 N	43.0 W	06	25	M 30	2 NM	63	1005.8	20.0	20.0	6	10	23	8	42.5
AMER LEGEND	AMERICAN	23	45.3 N	31.2 W	12	27	M 29	10 NM	60	1010.5	17.8	15.6	5	8	27	8	30
AMER ARCHER	AMERICAN	24	30.8 N	44.3 W	12	29	45	10 NM	13	1002.0	6.7	14.5	3	11.5	29	< 6	19.5
OSGEN WABASH	AMERICAN	31	39.3 N	70.6 W	00	04	48	10 NM	02	1022.7	18.0	16.7	4	11.5	04	6	19.5
GREAT LAKES VESSELS																	
JOHN DYKSTRA	AMERICAN	8	43.6 N	82.0 W	12	14	M 48	10 NM	18		9.0	14.0	6	13			
C H HUMPHREY	AMERICAN	8	41.9 N	82.7 W	12	16	M 41	2 NM	63		10.0	17.0	4	5			
NORTH ATLANTIC OCEAN		OCT.															
ENVIRONMENTAL BUOYS																	
EB 07	AMERICAN	17	39.0 N	70.0 W	09	23	M 44			999.8	14.2	22.2	3	14.5			

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

(Continued from previous page.)

SEPTEMBER D A T A S U M M A R Y E801
AVERAGE LATITUDE 36.0N AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.7	(09 00)	25.9	27.7	(10 19)	148	18
SEA TEMP (DEG C)	25.1	(03 00)	25.9	26.7	(01 18)	19	3
AIR-SEA TEMP (DEG C)	-00.7	(01 08)	02.3	01.8	(02 21)	19	3
PRESSURE (MBAR)	1010.6	(10 21)	1018.6	1028.2	(18 15)	169	21

WAVES - N FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 148

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
N FREQUENCY	38.3	38.8	8.8						1.0M	2.5M	(07 18)

SEPTEMBER D A T A S U M M A R Y E830
AVERAGE LATITUDE 58.2N AVERAGE LONGITUDE 152.7W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.1	(25 15)	11.1	13.3	(05 03)	126	25
SEA TEMP (DEG C)	09.5	(29 08)	11.0	12.0	(14 18)	122	25
AIR-SEA TEMP (DEG C)	-02.7	(03 00)	00.1	02.5	(09 03)	118	25
PRESSURE (MBAR)	0982.3	(21 03)	1012.0	1029.2	(13 19)	123	27

WIND - N FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL N	MEAN SPEED (KNOTS):	NO. OF OBS: 122
N	2.5	3.3					5.7	4.8	
NE	.8		1.8				2.5	10.3	MAX WIND
E	5.3	1.6	3.3	1.6			9.8	11.4	SPEED: 32 KNOTS
SE	1.6	2.5	5.7				9.0	11.2	DIRECTION: 250 DEG
S	1.6	6.6	.8				9.0	7.2	DAY: 28
SW	.8	9.2	2.5				11.5	8.1	HOUR: 08
W	.8	7.4	9.0	1.6			18.9	13.4	
NW	.8	6.6	23.8	2.5			33.8	14.4	
CALM	1						1	0	
TOTAL	11.5	36.1	46.7	5.7			100.0	11.8	

WAVES - N FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 107

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
N FREQUENCY	38.3	51.4	8.4	.8					1.0M	3.5M	(30 03)

OCTOBER D A T A S U M M A R Y E821
AVERAGE LATITUDE 48.0N AVERAGE LONGITUDE 131.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.9	(31 03)	13.7	18.5	(22 03)	198	21
SEA TEMP (DEG C)	12.8	(31 15)	14.4	16.0	(18 21)	198	21
AIR-SEA TEMP (DEG C)	-03.5	(23 09)	-00.8	01.7	(22 03)	198	21
PRESSURE (MBAR)	0988.2	(24 09)	1012.9	1030.9	(15 18)	198	21

WIND - N FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL N	MEAN SPEED (KNOTS)	NO. OF OBS: 198
N	1.3	.8					1.9	5.3	
NE	.8	.8					1.3	3.9	MAX WIND
E		1.8					1.8	6.7	SPEED: 42 KNOTS
SE		1.3	3.2	3.2	.8		8.2	21.2	DIRECTION: 180 DEG
S	.8	1.3	12.7	13.3	.8		28.9	21.2	DAY: 24
SW		1.3	13.9	7.0	.6		22.8	18.4	HOUR: 09
W		8.3	8.2	8.3	.8		21.9	18.7	
NW		6.3	5.7		1.8		13.8	14.3	
CALM	1						1	0	
TOTAL	2.9	18.8	43.7	29.7	4.4		100.0	18.0	

WAVES - N FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 147

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
N FREQUENCY		28.8	19.0	41.5	8.8	.7			3.0M	8.0M	(24 18)

SEPTEMBER D A T A S U M M A R Y E843
AVERAGE LATITUDE 58.0N AVERAGE LONGITUDE 142.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.5	(21 15)	12.2	16.0	(04 03)	80	0
SEA TEMP (DEG C)	12.0	(08 21)	13.7	15.0	(01 00)	80	0
AIR-SEA TEMP (DEG C)	-04.8	(21 15)	-01.4	02.1	(04 03)	80	0
PRESSURE (MBAR)	1004.8	(07 18)	1014.2	1021.8	(09 21)	98	0

WIND - N FREQUENCIES, MEANS AND EXTREMES

DIR	SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL N	MEAN SPEED (KNOTS)	NO. OF OBS: 98
N							0	0	
NE	3.4	1.7					5.1	3.7	MAX WIND
E	1.7						1.7	3.0	SPEED: 37 KNOTS
SE		1.7	30.9	3.4			40.1	13.7	DIRECTION: 070 DEG
S							3.4	2.6	DAY: 07
SW	5.1						5.1	1.3	HOUR: 19
W	1.7						1.7	3.0	
NW	3.4	19.3	9.1				23.7	7.9	
N	3.4	9.4					8.8	3.6	
CALM	1.7						1.7	0	
TOTAL	25.4	35.8	39.8	3.4			100.0	9.7	

WAVES - N FREQUENCIES, MEAN AND EXTREME (METERS): NO. OF WAVE OBS: 56

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
N FREQUENCY	62.5	21.4	12.5	3.6					.8M	3.0M	(07 21)

Table 7

Selected Gale and Wave Observations, North Pacific

September and October 1977

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec.	Sea Waves* Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		SEP.															
OVERSEAS CHICAGO	AMERICAN	9	40.2 N	126.4 W	18	33	45	10 NM	02	1016.0	16.7	13.5	8	11.5	36	9	36
OVERSEAS CHICAGO	AMERICAN	10	40.3 N	126.7 W	00	36	45	10 NM	02	1015.5	16.7	12.8	7	23	01	7	39
GLACIER	AMERICAN	13	59.7 N	171.2 W	06	18	M 47	1 NM	63	1001.3	12.7		7	10			
MONTIGNY	LIBERIAN	16	57.1 N	135.7 W	06	25	M 49	2 NM	50	1005.5	11.1	9.0	5	10	25	6	13
ARCTIC TOKYO	LIBERIAN	20	41.8 N	148.6 E	06	23	M 39	1 NM	07	987.0	21.0	19.0	9	11.5			
PRES MCKINLEY	AMERICAN	20	46.2 N	178.5 E	06	01	41	5 NM	02	1009.0	11.1	13.9	8	11.5	02	< 6	18
MONTIGNY	LIBERIAN	21	46.8 N	165.9 E	00	18	M 45	2 NM	03	1007.3	16.3	12.0	7	10			
EXXON PHILADELPHIA	AMERICAN	22	53.5 N	137.3 W	06	26	50	5 NM	21	1007.0	15.0	15.0	5	10			
GRAND CARRIER	LIBERIAN	25	42.4 N	163.2 E	06	26	M 43	10 NM	03	1000.0	17.0	17.0					
PRES JEFFERSON	AMERICAN	26	43.4 N	170.7 E	06	26	48	10 NM	02	1011.3	13.6	13.9	7	13	26	9	24.5
PACDUKE	LIBERIAN	26	46.5 N	164.1 E	00	32	M 44	1 NM	02	997.0	13.0	13.0	9	23			
ARCTIC TOKYO	LIBERIAN	28	51.1 N	171.6 E	18	14	M 48	1 NM	63	999.0	9.8	11.0	7	16.5	11	10	18
ALASKA STANDARD	AMERICAN	30	58.8 N	152.3 W	00	29	50	10 NM	01	1004.3	6.3	14.8	3	6.5	28	6	13
NORTH PACIFIC OCEAN		OCT.															
SEATRAIN LEXINGTON	GERMAN	3	40.9 N	164.3 E	06	29	55	2 NM	25	1007.9	13.0	17.2	10	19.5			
KOREA PHOENIX	SINGAPORE	3	35.7 N	141.3 E	05	03	M 44	10 NM	02	1022.0	22.0		5	6.5			
SEATRAIN LEXINGTON	GERMAN	4	40.1 N	171.0 E	00	31	44	5 NM	02	1012.9	18.0	17.5	5	8	31	7	11.5
RESSNES	LIBERIAN	5	37.6 N	148.9 E	12	20	M 42	1 NM	03	989.5	21.7		6	6.5	21	8	10
GLOMAR CHALLENGER	AMERICAN	5	39.9 N	145.5 E	06	04	M 43	2 NM	80	1006.3	17.0	21.4	5	5	08	7	11.5
PRES JEFFERSON	AMERICAN	6	54.0 N	161.9 W	18	29	50	10 NM	02	1007.0	8.3	9.4	9	24.5			
KOREA PHOENIX	SINGAPORE	6	47.3 N	149.4 E	23	14	M 48	.25 NM	60	998.3	14.0		6	10			
PRES JEFFERSON	AMERICAN	7	54.3 N	165.0 W	00	29	50	5 NM	81	1014.0	10.0	9.4	7	11			
GREEN ECHO	LIBERIAN	7	54.0 N	151.9 W	12	28	M 45	5 NM	02	1009.0	8.5	10.0	10	14.5			
VAN CONQUEROR	LIBERIAN	8	48.9 N	177.8 E	06	25	M 39	2 NM	60	991.0	9.0	12.0					
OVERSEAS ARCTIC	AMERICAN	8	57.0 N	143.1 W	06	27	42	10 NM	14	1000.2	7.3	10.0					
AMER LEGION	AMERICAN	11	39.2 N	172.3 W	18	20	41	2 NM	25	1000.5	18.9	18.9	6	16.5	17	8	13
CHESTNUT HILL	AMERICAN	11	36.9 N	179.6 E	18	31	45	5 NM	80	1007.1	18.8	20.5	RX	10	31	X	29.5
PRESIDENT MADISON	AMERICAN	12	53.7 N	149.5 W	06	23	M 48	5 NM	61	989.5	10.0	11.1	6	19.5			
CHESTNUT HILL	AMERICAN	12	36.6 N	179.5 E	00	31	45	5 NM	03	1012.2	21.1	21.1		10	32	< 6	13
AMER LEGION	AMERICAN	13	38.3 N	134.2 W	12	26	52	5 NM	07	988.1	18.3	19.4	9	10	24	11	19.5
ASIA ZEBRA	LIBERIAN	13	53.3 N	148.0 W	00	26	42	5 NM	01	1003.3	10.0	13.0	8	13	26	12	19.5
KOREAN LEADER	KOREAN	13	37.2 N	140.1 E	06	00	M 48	5 NM	02	998.8	19.0	22.0	9	19.5	30	8	24.5
PRES TAFT	AMERICAN	13	39.3 N	153.7 W	18	25	60	1 NM	07	999.0	15.6	17.3	7	32.5	23	6	36
PACIFIC ARROW	JAPANESE	13	38.1 N	136.1 W	12	29	M 50	10 NM	02	993.5	16.0	20.6					
ALASKA STANDARD	AMERICAN	14	59.6 N	144.7 W	20	08	45	2 NM	62	981.0	7.8	13.4			08	7	10.5
GEORGIANA	LIBERIAN	14	42.7 N	179.2 W	12	09	M 45	1 NM	59	1004.0	14.0	18.0	5	6.5	06	7	10
SEALAND COMMERCE	AMERICAN	14	47.3 N	134.4 W	00	18	65	1 NM	02	997.8	8.9	11.2	7	13	04	10	16.5
SONGKHLA	DANISH	14	49.7 N	149.6 W	12	18	M 60	5 NM	03	970.5	14.0		10	32.5			
PRES TAFT	AMERICAN	14	38.8 N	153.2 W	00	28	55	10 NM	02	998.0	17.2	18.3	9	28	27	6	36
SANTA MARIA	AMERICAN	14	52.3 N	138.7 W	12	13	45	1 NM	18	992.9	13.3	12.2					
RESSNES	LIBERIAN	14	48.1 N	139.8 W	00	15	M 42	1 NM	20	1002.0	14.0		5	8	13	9	10
GEORGIANA	LIBERIAN	15	53.0 N	179.8 E	06	35	M 44	.5 NM	45	991.0	16.0	16.0	8	11.5	06	10	11.5
GREAT LAND	AMERICAN	15	53.5 N	140.5 W	12	20	M 61	5 NM	02	981.0	10.6	11.7					
HIBI MARU	JAPANESE	15	39.2 N	177.1 W	06	32	M 42	2 NM	02	1010.0	13.0	18.3	7	6.5	31	10	16.5
SANTA MARIA	AMERICAN	15	51.7 N	137.2 W	00	19	45	2 NM	07	992.6	13.9	13.3	7	18	16	9	28
SANTA CLARA	AMERICAN	15	55.9 N	144.8 W	00	14	45	5 NM	60	987.5	11.2	10.6	6	11.5	16	10	19.5
OVERSEAS CHICAGO	AMERICAN	15	55.1 N	179.6 E	12	18	43	5 NM	18	995.3	10.6	10.0	5	8	21	10	23
ALEUTIAN DEVELOPER	AMERICAN	16	55.5 N	160.3 W	18	36	55	10 NM	03	989.8	2.2	9.4	2	8			
GREAT LAND	AMERICAN	16	57.4 N	146.3 W	00	22	M 55	5 NM	02	989.3	8.9	10.6	5	8	22	7	16.5
PRESIDENT MADISON	AMERICAN	16	47.3 N	158.6 E	06	17	M 46	10 NM	02	1009.0	12.8	11.7	6	10	20	6	10
ATLANTIC PIONEER	PANAMANIAN	17	52.7 N	140.1 W	06	22	M 48	2 NM	03	1000.2	11.0	10.0	8	24.5	22	>13	36
DISCOVERER	AMERICAN	17	58.2 N	149.9 W	21	29	M 45	5 NM	03	990.5	0.0	7.2	8	24.5			
ARCO SAG RIVER	AMERICAN	17	56.3 N	139.8 W	12	22	48	5 NM	01	992.0	10.0	9.5	5	16.5	21	8	24.5
ALEUTIAN DEVELOPER	AMERICAN	17	57.2 N	155.5 W	12	32	58	10 NM	02	991.5	0.0	8.9	5	19.5			
WESTWARD VENTURE	AMERICAN	17	56.1 N	141.3 W	12	21	M 50	10 NM	01	986.5	10.0	11.0			24	7	24.5
PRESIDENT MADISON	AMERICAN	17	41.7 N	149.1 E	06	27	M 42	10 NM	02	1017.8	13.6	13.6	6	13			
CHEVRON WASHINGTON	AMERICAN	17	52.8 N	142.3 W	03	23	50	5 NM	02	998.0	9.1		8	16.5	23	< 6	14.5
DISCOVERER	AMERICAN	18	58.2 N	150.3 W	06	29	M 34	5 NM	02	992.9	1.1	7.8	9	29.5			
ALEUTIAN DEVELOPER	AMERICAN	18	58.8 N	152.0 W	06	29	55	5 NM	70	998.3	1.1	7.8	5	14.5			
ASIA ZEBRA	LIBERIAN	19	48.9 N	143.8 E	21	28	55	5 NM	60	984.5	7.0	10.0	11	37.5	28	11	41
ARCTIC TOKYO	LIBERIAN	20	51.0 N	171.5 E	06	08	M 30	1 NM	69	980.0	3.3	8.0	7	19.5			
ASIA ZEBRA	LIBERIAN	20	48.3 N	153.0 E	03	29	65	.5 NM	65	984.3	6.3	11.0	11	37.5	29	12	42.5
GOLDEN ARROW	JAPANESE	20	48.7 N	167.3 W	18	07	M 49	.5 NM	64	984.0	8.0	10.0	7	13			
ORIENTAL SOVERIGN	LIBERIAN	20	49.0 N	166.0 W	18	08	M 52	2 NM	63	988.0	8.0	10.5	9	23			
LIECHTENSTEIN	LIBERIAN	20	43.1 N	140.5 W	23	23	M 45	.5 NM	03	983.0	19.0	13.3	6	29.5			
OJI GLORIA	LIBERIAN	20	38.0 N	179.8 W	06	22	M 48	2 NM		1000.5	20.0						
OVERSEAS CHICAGO	AMERICAN	20	53.3 N	135.5 W	18	12	50	5 NM	62	996.8	11.7	10.0	5	8	15	9	23
GENERAL SUMIDA	LIBERIAN	20	44.0 N	167.0 W	18	27	M 55	.25 NM	67	979.0	10.0	11.0					
CHEVRON LOUISIANA	AMERICAN	20	51.8 N	138.7 W	00	16	M 45	10 NM	62	1007.2	9.0		4	5	16	8	14.5
FEDERAL SUMIDA	LIBERIAN	21	44.0 N	165.0 W	00	25	M 63	200 YD	43	976.0	10.0	11.0					
ATLANTIC PIONEER	PANAMANIAN	21	52.0 N	169.3 W	18	31	M 41	2 NM	79	998.0	3.0	9.5	6	10	33	10	14.5
ORIENTAL SOVERIGN	LIBERIAN	21	48.9 N	165.5 W	00	02	M 52	2 NM	25	970.0	7.5	10.5	9	23	05	12	16.5
LIECHTENSTEIN	LIBERIAN	21	42.6 N	141.4 W	18	23	M 39	200 YD	03	979.5	10.2	12.8	6	41	27	>13	50.5
WESTWARD VENTURE	AMERICAN	21	51.6 N	131.0 W	18	17	M 42	2 NM	29	999.6	12.2	11.7	2	3	12	12	14.5
WASHINGTON RAINBOW	JAPANESE	21	33.4 N	137.0 E	12	09	M 42	5 NM	03	1023.3	22.2	27.0	4	6.5	09	6	10
SURVEYOR	AMERICAN	21	56.4 N	146.3 W	18	15	M 45	2 NM	02	983.1	7.2	8.3		8	10	11	8
AMERICA MARU	JAPANESE	21	41.0 N	135.5 W	06	23	M 48	.5 NM	25	991.0	16.0	18.0	8	13	23	11	16.5
AMER LYNX	AMERICAN	21	40.7 N	176.7 E	00	29	45	10 NM	02	1011.0	15.0	17.3	12	24.5			
AMER MAIL	AMERICAN	21	43.6 N	178.2 E	00	29	45	10 NM	01	1009.8	10.6	10.0	6	11.5	30	11	39
JAPAN ACE	JAPANESE	21	37.0 N	150.3 W	12	23	M 41	5 NM	02	1004.0	21.5	17.0	5	10	25	9	8
TRANSCHAMPLAIN	AMERICAN	22	13.8 N	145.3 E	12	34	47	5 NM	82	1000.0	27.8	30.0	3	14.5	24	8	19.5
WASHINGTON RAINBOW	JAPANESE	22	33.4 N	139.7 E	00	07	M 44	10 NM	01	1023.4	21.0	26.0	4	6.5	07	6	10
AMERICA MARU	JAPANESE	22	40.3 N	159.2 W	00	29	M 22	10 NM	01	1004.0	12.0	18.0	4	10	27	10	44
PRES TAFT	AMERICAN	22	37.4 N	155.8 W	18	29	47	5 NM	02	1017.3	22.2	17.8			35	< 6	11.5
PORTLAND	AMERICAN	22	58.4 N	149.5 W	00	06	30	2 NM	18	980.1	5.0	7.8	4	11.5	08	< 6	16.5
OJI GLORIA	LIBERIAN	22	39.2 N	172.1 E	00	23	M 49	1 NM	04	1000.2	22.0						
GREAT LAND	AMERICAN	22	56.6 N	142.5 W	12	21	M 42	5 NM	02	984.0	8.3	9.4					
JAPAN BEAR	AMERICAN	22	37.4 N	152.8 W	06	28	M 32	10 NM	01	1008.3	16.1	17.2	6	16.5	32	8	32.5

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C		Sea Waves?		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°	Speed kt.				Air	Sea	Period sec.	Height ft.	Dir. 10°	Period sec.	Height ft.
NORTH PACIFIC OCEAN		OCT.															
GREEN AUKLET	PANAMANIAN	22	51.7 N	148.3 W	00	32	M 43	2 NM	03	958.0	9.0	10.0	6	14.8			
MORIL MERIDIAN	AMERICAN	22	57.8 N	143.7 W	18	18	45	10 NM	27	970.9	5.0	8.9	3	10	18	10	19.8
POLLY TURMAN	AMERICAN	22	34.1 N	149.2 E	06	05	M 35	10 NM	03	1017.3	21.1	22.8	7	6.5	05	>13	16.5
ALEUTIAN DEVELOPER	AMERICAN	22	54.5 N	163.9 W	12	28	65	1 NM	86	977.7	3.1	8.9	4	18			
CALIFORNIAN	AMERICAN	22	44.2 N	132.5 W	06	19	47	3 NM	02	1003.3	17.2	17.2	3	6.5	19	9	19.3
TRIUMPH	PANAMANIAN	23	52.5 N	141.6 W	01	20	M 27	5 NM	02	992.0	7.0	12.0	6	19.5	20	9	32.3
PRES EISENHOWER	AMERICAN	23	34.4 N	157.0 W	18	32	49	10 NM	01	1013.5	17.8	22.2	8	14.5	32	9	19.5
QUEENS WAY BRIDGE	JAPANESE	23	37.0 N	155.3 W	18	31	M 41	2 NM	02	1008.0	17.0	18.5	9	23	29	11	29.5
JAPAN ACE	JAPANESE	23	36.1 N	164.0 W	06	27	M 38	5 NM	01	1002.5	19.0	17.0	7	13	27	9	16.5
KOREA PHOENIX	SINGAPORE	23	44.9 N	149.2 W	23	32	M 60	.5 NM	10	972.3	8.0		XX	16.5	32	7	26
GREAT LAND	AMERICAN	23	57.2 N	145.1 W	00	18	M 50	5 NM	02	973.0	8.3	8.4	6	24.5			
JAPAN BEAR	AMERICAN	23	34.8 N	163.0 W	12	30	M 60	5 NM	02	1011.0	18.3	19.4	5	13	29	9	32.5
FEDERAL SUMIDA	LIBERIAN	23	46.7 N	143.7 W	18	14	M 50	.25 NM	63	981.5	12.0	12.0					
CHEVRON MISSISSIPPI	AMERICAN	23	59.0 N	151.3 W	00	05	50	1 NM	63	982.0	8.3	7.2	3	8	07	8	11.5
ALEUTIAN DEVELOPER	AMERICAN	23	54.3 N	166.6 W	06	32	50	5 NM	02	992.2	3.9	7.2			30	X	23
SEALAND EXCHANGE	AMERICAN	24	41.1 N	147.7 W	06	27	47	2 NM	02	1000.7	10.0	13.9	5	11.5			
WESTWARD VENTURE	AMERICAN	24	43.8 N	135.6 W	12	12	M 42	5 NM	65	980.0	10.0	10.0			12	6	11.5
ASIA MORALITY	LIBERIAN	24	39.5 N	158.6 E	06	09	M 45	.25 NM	63	1000.3	19.0	24.0	7	16.3			
AMER MAIL	AMERICAN	24	48.0 N	145.0 W	18	28	60	.5 NM	07	979.7	8.3	8.9	8	29.5	30	>13	49
SEALAND MC LEAN	AMERICAN	24	49.0 N	136.9 W	18	25	50	2 NM	51	984.0	8.6	8.3	7	11.5	25	< 6	16.5
PAC PRINCE	LIBERIAN	24	36.3 N	148.5 E	06	01	44	5 NM	02	1002.5	22.0	24.0	5	8	04	9	10
PRES JEFFERSON	AMERICAN	24	43.2 N	180.4 E	18	03	50	2 NM	63	968.5	12.2	13.9					
PRES LINCOLN	AMERICAN	24	43.8 N	159.2 E	18	03	55	5 NM	51	981.0	10.6	13.0	4	8	03	10	16.5
LAUREL	LIBERIAN	24	49.0 N	140.6 W	06	36	M 54	.5 NM	05	1005.1	20.5	20.0	3	11.5	25	9	19.5
LING YUNG	CHINESE	24	35.8 N	145.1 W	00	27	M 42	5 NM	05	1005.1	20.5	20.0	3	11.5	25	9	19.5
PHILADELPHIA	AMERICAN	24	53.3 N	159.5 W	18	09	68	5 NM	20	982.4	7.2	7.8	12	19.8	09	9	32.3
MORIL ARCTIC	AMERICAN	24	54.8 N	143.1 W	18	45	56	2 NM	58	971.2	8.1	6.1	5	10	12	>13	39
OVERSEAS CHICAGO	AMERICAN	24	51.1 N	180.0 W	18	19	50	2 NM	62	979.0	10.0	10.0	XX	10	19	12	24.5
ORIENTAL SOVERIGN	LIBERIAN	24	47.2 N	142.4 W	12	27	M 55	1 NM	25	988.0	9.0	12.5	10	13	27	12	14.5
KOREA PHOENIX	SINGAPORE	24	41.8 N	147.8 W	23	28	M 60	10 NM	02	1011.0	12.0		XX	13	26	>13	26
WAYNE	AMERICAN	24	38.5 N	154.4 E	12	34	48	2 NM	51	986.4	17.8	20.0	4	8	03	6	6.5
FEMERAL SUMIDA	LIBERIAN	24	47.7 N	138.2 W	18	25	M 70	1 NM	09	973.0	11.0	13.0					
BELLADONA VENTURE	LIBERIAN	24	44.3 N	148.0 W	03	29	M 60	.5 NM	02	973.0	9.0	14.0	5	13	28	9	18
CALIFORNIAN	AMERICAN	24	34.4 N	141.0 W	06	27	48	10 NM	01	1010.0	20.5	22.2	3	8	27	8	11.5
PRES PIERCE	AMERICAN	25	50.2 N	129.3 W	18	21	50	1 NM	63	989.0	13.3	10.6	8	11.5	24	11	24.5
WASHINGTON RAINBOW	JAPANESE	25	30.7 N	134.0 E	18	03	M 44	2 NM	50	1004.2	22.0	27.0	7	14.5			
SEALAND MC LEAN	AMERICAN	25	48.8 N	129.9 W	06	20	45	5 NM	50	996.5	8.8	10.7	9	14.5			
TRIUMPH	PANAMANIAN	25	54.3 N	159.9 W	23	22	M 42	5 NM	03	988.0	8.0	9.0	9	16.5	22	8	28
VAN TRIUMPH	LIBERIAN	25	47.8 N	171.2 E	18	19	M 50	1 NM	60	990.0	11.0	10.0					
AMER MAIL	AMERICAN	25	47.9 N	142.5 W	00	28	55	.5 NM		979.7	7.2	8.9	6	21	29	>13	41
RUSH	AMERICAN	25	52.1 N	176.3 W	21	27	65	.5 NM	65	988.0					27	7	29.5
ASIA MORALITY	LIBERIAN	25	40.1 N	162.9 E	00	32	M 42	1 NM	02	1000.2	16.0	22.0	7	19.8			
PRES QUEZON	PHILIPPINE	25	32.6 N	164.3 E	12	19	M 41	.5 NM	05	1015.0	23.0	27.0					
ORIENTAL SOVERIGN	LIBERIAN	25	49.2 N	138.6 W	00	34	M 58	5 NM	02	984.5	10.0	12.0	10	13	27	12	14.5
PORTLAND	AMERICAN	25	52.7 N	138.2 W	18	29	56	3 NM	02	983.7	7.8	7.3	3	10	29	7	19.5
PRES FILLMORE	AMERICAN	25	46.0 N	175.5 E	06	20	60	.5 NM	21	972.0	12.8	11.1	5	8	20	8	24.5
LAUREL	LIBERIAN	25	48.1 N	142.0 W	00	27	M 46	.5 NM	18	979.0	6.3	10.0	3	11.5	29	6	13
OVERSEAS CHICAGO	AMERICAN	25	50.6 N	130.5 W	06	22	50	2 NM	62	991.5	11.2	10.0	XX	19.8	22	>13	65.5
NORTH STAR III	AMERICAN	25	53.6 N	148.0 W	18	27	M 50	2 NM	62	985.3	11.0	7.8	8	14.5			
PHILADELPHIA	AMERICAN	25	54.2 N	140.5 W	00	03	65	2 NM	62	980.4	10.0	7.8	4	19.5	05	6	32.5
KOREA PHOENIX	SINGAPORE	25	41.8 N	153.7 W	23	23	M 45	10 NM	02	1024.0	12.0		3	10	23	>13	16.5
PRES JEFFERSON	AMERICAN	25	42.7 N	163.3 E	06	33	55	5 NM	02	1008.0	10.0	10.6	7	24.3	33	8	44
PRES LINCOLN	AMERICAN	25	43.8 N	180.4 E	00	32	55	2 NM	01	993.5	8.3	12.2			33	9	24.5
ATLANTIC PIONEER	PANAMANIAN	25	47.7 N	180.0 E	00	31	M 58	.25 NM	65	977.7	4.5	9.0	8	19.5	35	12	29.5
GOLDENROD	LIBERIAN	25	46.2 N	178.0 E	06	21	M 51	200 YD	07	969.5	11.0	10.0	XX	49	21	12	57
GOLDEN MARINER	PANAMANIAN	25	51.5 N	168.1 E	15	31	M 51	5 NM	63	999.0	2.0	7.0	8	11.5			
FEMERAL SUMIDA	LIBERIAN	25	48.0 N	136.0 W	00	25	M 70	.25 NM	09	982.0	10.0	11.0					
ALEUTIAN DEVELOPER	AMERICAN	25	54.2 N	161.8 W	21	20	60	2 NM	62	988.3	9.4	8.9	4	14.8	20	6	24.5
EXXON PHILADELPHIA	AMERICAN	26	51.2 N	135.4 W	18	19	60	1 NM	63	984.3	12.8	11.1	6	13	26	12	13
ARCO FAIRBANKS	AMERICAN	26	47.5 N	178.4 W	18	19	M 60	2 NM	02	995.9	13.0	10.0	3	11.5	22	10	29.5
VAN TRIUMPH	LIBERIAN	26	47.3 N	160.5 W	18	29	M 60	1 NM	10	998.0	7.0	8.0					
SEALAND TRADE	AMERICAN	26	47.4 N	153.4 W	18	26	45	2 NM	02	983.0	7.2	8.3	15	16.8	26	7	24.5
SHUNWIND	LIBERIAN	26	43.0 N	157.6 W	06	22	M 68	1 NM		998.0	12.0	12.0					
TRIUMPH	PANAMANIAN	26	53.8 N	160.4 W	05	20	M 50	1 NM	28	962.0	4.0	9.0	6	26	20	>13	36
VAN ENTERPRISE	LIBERIAN	26	41.4 N	160.8 W	06	23	M 41	5 NM	02	1016.0	19.6	19.0			24	8	14.8
RUSH	AMERICAN	26	52.2 N	176.8 W	03	30	70	.5 NM	07	983.1					30	8	34.5
ROUTWELL	AMERICAN	26	38.0 N	178.2 W	03	35	M 46	2 NM	88	977.9	1.0	5.0	12	23	03	8	8
GREEN AUKLET	PANAMANIAN	26	53.7 N	174.9 W	00	31	M 59	200 YD	44	982.0	5.0	9.0			31	9	49
GOLDENROD	LIBERIAN	26	47.1 N	176.7 W	06	30	M 51	2 NM	27	1013.7	6.0	9.0	12	29.5	30	12	32.3
ALEUTIAN DEVELOPER	AMERICAN	26	54.1 N	161.8 W	00	21	70	2 NM	03	982.8	8.3	8.9	3	14.5	22	8	41
JAPAN BEAR	AMERICAN	26	37.0 N	165.3 E	22	18	M 44	2 NM	05	1000.0	22.2	19.4	12	19.5	18	11	19.5
ARNOLD MAERSK	DANISH	26	43.5 N	149.0 W	18	27	50	5 NM	05	1002.0	11.8	9.0	6	6.5	27	>13	21
CHEVRON MISSISSIPPI	AMERICAN	26	59.1 N	152.0 W	12	11	60	.5 NM	65	981.1	4.6	4.4	3	6.5	11	X	10
KASMU MARU	JAPANESE	26	43.0 N	157.2 W	12	26	M 52	.5 NM		996.5	10.0	9.0	6	11.5	26	8	28
PRES ROOSEVELT	AMERICAN	26	43.0 N	154.8 W	12	27	42	5 NM	01	998.5	8.9	11.1	4	8			
PRES QUEZON	PHILIPPINE	26	33.5 N	161.3 E	18	19	M 65	30 YD	05	998.0	24.0	29.0					
PACBARONESS	LIBERIAN	26	54.3 N	167.9 W	00	23	M 43	5 NM	62	993.2	5.5	10.0	6	11.5	23	11	32.3
KOREA PHOENIX	SINGAPORE	26	40.5 N	138.8 W	17	31	M 43	3 NM	02	1023.0	13.0		5	8	31	>13	23
MORIL ARCTIC	AMERICAN	26	49.1 N	136.9 W	18	19	47	5 NM	50	994.9	12.7	9.4	4	8	19	10	14.5
NORTH STAR III	AMERICAN	26	54.0 N	162.2 W	12	32	48	5 NM	02	982.0	9.0	8.3	7	14.5	27	12	34.5
MORIL MERIDIAN	AMERICAN	26	53.9 N	138.0 W	18	16	60	2 NM	63	978.3	9.5	8.9	3	6.5	18	9	19.5
PRES FILLMORE	AMERICAN	26	45.7 N	177.9 W	00	29	48	5 NM	02	1010.2	5.8	10.0	4	6.5	28	8	19.5
PRES PIERCE	AMERICAN	26	53.2 N	139.0 W	18	18	43	2 NM	63	999.9	10.6	8.3	8	13	18	8	16.3
TRIUMPH	PANAMANIAN	27	52.8 N	162.8 W	00	32	M 48	1 NM	03	991.5	5.0	8.0	6	26	32	12	36
VAN TRIUMPH	LIBERIAN	27	46.6 N	158.7 W	00	31	M 57	1 NM	10	1003.0	8.0	8.0					
SEALAND TRADE	AMERICAN	27	47.3 N	150.5 W	00	26	48	2 NM	02	982.4	8.3	8.3	15	19.8			
VAN ENTERPRISE	LIBERIAN	27	42.3 N	155.9 W	00	29	M 47	2 NM	01	1014.5	15.3	12.0			29	X	32.5
KASMU MARU	JAPANESE	27	44.8 N	151.7 W	00	27	M 50	.5 NM		999.0	8.3	9.0	8	14.5	26	>13	36
ARNOLD MAERSK	DANISH	27	41.8 N	146.7 W	00	27	50	5 NM	02	1005.5	13.2	13.0	6	21			
ALBERT MAERSK	DANISH	27	48.2 N	140.1 W	00	26	50	5 NM	81	991.0	11.0		10	23			
PRES ROOSEVELT	AMERICAN	27	43.4 N	149.6 W	00	28	42	5 NM	01	1003.7	10.0	12.2	4	8			
PRES PIERCE	AMERICAN	27	53.8 N	150.8 W	18	32	43	5 NM	02	981.7	8.3	9.7	8	10	30	8	16.5
KENSHO MARU	JAPANESE	27	51.2 N	147.8 W	00	23	M 44	.25 NM	60	994.9	8.0	8.0	8	32.8	27	12	36
WAYNE	AMERICAN	27	46.8 N	179.7 W	18	32	48	2 NM	02	990.4	9.0		8	13	17	9	13
NORTH STAR III	AMERICAN	27	52.8 N	153.9 W	12	31	43	2 NM	63	983.4	9.0	7.8	8	19.8	28	12	24.5
MORIL MERIDIAN	AMERICAN	27	53.8 N	137.0 W	00	21	50	5 NM	19	976.6	9.3	9.3	5	6.5	21	10	24.5
ALEUTIAN DEVELOPER	AMERICAN	27	56.2 N	153.4 W	12	32	65	2 NM	64	978.0	2.9	7.8	3	14.5			
EXXON PHILADELPHIA	AMERICAN	27	50.9 N	134.9 W	00	18	42	1 NM	61	987.2	11.2	11.7	8	14.5	21	12	16
EXXON SAN FRANCISCO	AMERICAN	27	51.1 N	134.6 W	00	16	48	2 NM	55	986.5	12.2	12.2	8	31	21	12	36

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C Air	Temperature °C Sea	Sea Waves+ Period sec.	Sea Waves+ Height ft.	Swell Waves Dir. 10°	Swell Waves Period sec.	Swell Waves Height ft.
NORTH PACIFIC OCEAN		OCT.															
ARCO FAIRBANKS	AMERICAN	27	48.4 N	140.3 W	18	27	M 26	5 NM	64	986.0	9.8	10.0	4	10	27	10	59
KOREA PHOENIX	SINGAPORE	27	41.1 N	163.5 W	23	25	M 47	5 NM	02	1019.5	18.0		6	8	25	< 6	19.5
GOLDENROD	LIBERIAN	27	46.6 N	169.8 W	00	30	M 38	5 NM	02	1026.7	7.5	9.0	16	28	30	12	32.5
SEALAND EXCHANGE	AMERICAN	27	44.7 N	171.8 E	12	35	48	5 NM	02	1003.0	6.8	8.9	5	8	35	6	14.5
SHUNYO	LIBERIAN	27	48.1 N	191.9 W	03	27	M 35	1 NM	07	991.5	11.5	12.0	8	41	29	9	55.5
ALASKAN MAIL	AMERICAN	27	42.8 N	196.9 W	00	30	43	5 NM	02	1017.3	10.6	11.7	6	16.5	30	8	29.5
DISCOVERER	AMERICAN	27	56.3 N	197.1 W	12	30	M 42	5 NM	02	986.0	3.7	7.5	3	13			
KOREA PHOENIX	SINGAPORE	28	41.4 N	165.2 W	03	31	M 42	7 NM	02	1011.0	13.0		6	10	31	8	16.5
ALBERT MAERSK	DANISH	28	46.2 N	145.7 W	00	31	50	2 NM	81	996.5	10.0	9.0	11	39			
ARCO FAIRBANKS	AMERICAN	28	46.0 N	140.6 W	00	27	M 25	5 NM	03	990.0	10.6	10.0	3	10	27	>13	49
GOLDENROD	LIBERIAN	28	46.4 N	194.1 W	18	28	M 44	1 NM		992.0	8.9	9.0	15	16.5	27	>13	29.5
PRES JEFFERSON	AMERICAN	28	46.1 N	161.2 W	06	22	35	10 NM	01	994.8	10.6	7.8	5	10	22	7	24.5
PRES LINCOLN	AMERICAN	28	51.2 N	185.4 W	06	15	45	5 NM	02	981.0	2.7	4.4	5	8	15	8	13
PRES PIERCE	AMERICAN	28	53.7 N	152.6 W	00	31	50	5 NM	02	982.0	5.0	7.2	8	24.5	27	12	19.5
SHUNYO	LIBERIAN	28	46.3 N	146.1 W	00	30	M 43	10 NM	03	997.0	8.5	12.0	8	29.5	31	11	46
TRIUMPH	PANAMANIAN	28	50.3 N	187.1 W	00	14	M 30	5 NM	10	981.5	1.0	7.0	6	13	14	10	23
ALBERT MAERSK	DANISH	29	42.3 N	194.2 W	00	29	30	2 NM	02	1010.5	12.5	11.0	9	16.5	29	X	32.5
COLORADO	AMERICAN	29	28.3 N	141.0 E	12	05	42	5 NM	02	1013.8	22.7	26.2	4	8	06	7	14.5
PRESIDENT MADISON	AMERICAN	29	40.9 N	180.1 E	18	01	M 45	10 NM	02	1024.0	10.0	17.2	4	6.5	32	6	10
MORIL ARCTIC	AMERICAN	29	42.5 N	173.9 W	18	22	42	5 NM	64	1004.1	14.4	12.7	4	5	21	10	8
CHEVRON MISSISSIPPI	AMERICAN	30	43.7 N	132.8 W	00	32	40	10 NM	15	1007.5	10.9	12.2	3	10	29	6	32.5
SHUNYO	LIBERIAN	30	47.9 N	180.8 W	00	31	M 42	10 NM	02	995.0	10.0	14.0	6	16.5	31	8	26
VAN TRIUMPH	LIBERIAN	30	47.1 N	134.1 W	00	30	M 42	10 NM	02	1006.0	10.0	15.0					
KOREA PHOENIX	SINGAPORE	31	44.5 N	149.2 E	17	21	M 43	5 NM	02	1025.0	9.5		6	6.5			
PRES PIERCE	AMERICAN	31	47.9 N	181.0 E	12	29	45	2 NM	63	1005.8	11.7	7.2					
PACBARRENESS	LIBERIAN	31	46.0 N	196.0 E	06	22	M 64	200 YD	41	1012.0	11.0	10.0	4	13			
NORTH PACIFIC OCEAN		OCT.															
ENVIRONMENTAL BUOYS																	
EB 03	AMERICAN	22	56.0 N	147.9 W	12	22	M 48			954.8	4.9	8.4	4	21			
EB 03	AMERICAN	23	56.0 N	147.9 W	00	18	M 44			966.4	4.1	7.6	4	21			
EB 17	AMERICAN	26	52.0 N	156.0 W	00	20	M 44			976.4	8.4	7.7	4	16.5			
EB 17	AMERICAN	27	52.0 N	156.0 W	09	31	M 45			986.4	5.7	6.1	5	26			
EB 19	AMERICAN	24	51.0 N	136.0 W	21	22	M 46			958.9	8.6	10.8					
EB 19	AMERICAN	25	51.0 N	136.0 W	00	22	M 49			964.4	7.9	10.7					
EB 20	AMERICAN	24	41.1 N	137.8 W	03	22	M 43			993.7	18.1		4	14.5			
EB 21	AMERICAN	24	46.0 N	131.0 W	09	16	M 42			989.2	14.2	14.4	4	16.5			

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

(Continued from page 115.)

Greek-registered PANTELIS A. LEMOS was due Vancouver with heavy weather damage. The 35,751-ton Kuwait-registered tanker AL-SABBIYAH developed a crack in her fuel tank on the 20th in rough seas about 40 mi off Muroto Misaki. The barges GALENA and NORTON SOUND in tow of the tug CLARION from Dutch Harbor were cut adrift in a heavy gale on the 26th. The barges were later located at Moffett Point, 25 mi north of Cold Bay.

The American containership PRESIDENT JEFFERSON (21,467 tons) sustained container damage from heavy weather and high winds. She was due Seattle on the 29th. The British ALMERIA STAR (7,615 tons) was at Kobe on the 31st with heavy weather damage. The American cargo vessel ILLINOIS (13,156 tons) diverted to Honolulu on the 27th when containers toppled in heavy weather and vessel lost power. The American crabber EAGLE (176 tons) sank in heavy weather in Alaska waters on the 26th. All crewmembers except the Master were found alive 10 days later.

Rough Log, North Atlantic Weather

December 1977 and January 1978

ROUGH LOG, DECEMBER 1977--There were not as many significant LOWs over the waters of the North Atlantic as normal. The primary storm path was from the Great Plains States across the Great Lakes to the Hudson Strait. There were secondary tracks along the East Coast of the United States toward Newfoundland and from the central ocean near latitude 50°N northeastward to eastern Iceland. One storm tracked from North Carolina to Ireland and Scandinavia. The climatological primary tracks are from the Great Lakes to near Cape Cod to the Labrador Sea and south of Newfoundland to Iceland.

The monthly mean pressure pattern differed from the climatological pattern as would be expected. The one feature this month that compared favorably with climatology was the primary Icelandic Low. It is normally positioned near 62°N, 30°W, at 1000 mb. This month it was 998 mb near 58°N, 37°W. The cyclonic circulation over the northern waters differed from climatology near the position of the secondary Low. It is usually over the Norwegian Sea at 1001 mb between Iceland and Norway. This month it was 1000 mb over Nova Zemlya. The Bermuda-Azores High at 1022 mb was centrally located over the ocean near 28°N, 47°W, about 1,200 mi southwest of its climatic position. This westerly shift of the High resulted in a trough off the west coast of Europe.

It was in association with this trough that the major negative anomaly occurred at minus 7 mb. Central Europe was dominated by a positive 9-mb anomaly. There were two other positive centers--a 4 mb over the ocean near 25°N, 48°W, and a 6 mb near Cape Chidley. The pressure over the north-central United States was below normal with a center over the Great Plains and another over the Great Lakes.

The upper air flow was mainly zonal over the western ocean. The sea-level trough over the eastern ocean was reflected in the higher levels off Europe. with a ridge alined along longitude 10°E.

The annual article describing the North Atlantic tropical cyclones for 1977 appears in this issue.

Extratropical Cyclones--This was a series of relatively small cyclones that formed in a large cyclonic circulation that was centered over midocean near 55°N. As the last storm described in the November Log approached Kap Farvel, another LOW formed near 48°N, 35°W, late on the 3d. The MEYNELL was in the southwestern quadrant with 55-kn westerly winds. By midday on the 4th the 970-mb LOW was at 52°N, 25°W. Ships south and west of the center were reporting 40- to 50-kn winds with seas and swells to 23 ft. At 0000 on the 5th, the SQHF was near 46°N, 37°W, or about 700 mi southwest of the center with 65-kn winds. Later in the day the storm turned toward the north with gales and 20-ft seas south of the center. The C.P. DISCOVERER (54°N, 29°W) was sailing into 76-kn winds and 20-ft waves. On the 6th the storm was heading northwestward, and another center formed off Lands End. This center crashed onto the Greenland coast on the 8th.

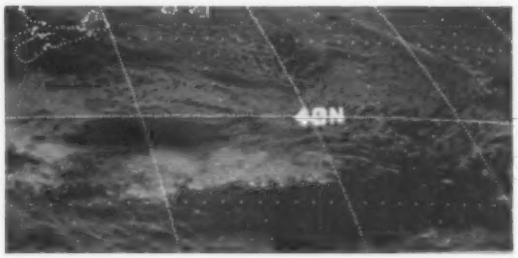


Figure 51.--This geostationary satellite image indicates the cloud center near 47°N, 44°W, at 1700 on the 5th.

A shallow, ill-defined LOW had tracked across the United States to the East Coast, but it could not be analyzed on the charts of the 4th. On the 5th it appeared to redevelop south of Newfoundland. By 1200 it was 990 mb near 44°N, 40°W (fig. 51). The HANNOVER about 180 mi south of the center was battered by 65-kn winds driving 26-ft seas and swells. Six hours later the SQHF and STOLT LLANDAFF were straddling the center with the same 984-mb pressure and 84- and 60-kn winds, respectively. On the 6th another small center developed east of this one. The gradient and windspeeds relaxed in that quadrant, but they increased in the western quadrant. The tug BILLY B. put into Vigo, Spain, on the 6th after heavy weather washed off some of her tank covers. The same three ships named above were caught with 50- to 65-kn winds. The HANNOVER reported 56-ft swells near 41°N, 41°W, and the STOLT LLANDAFF reported 44-ft swells near 45°N, 39°W. By the 7th a new cyclone absorbed both this LOW and the one that had previously formed near Lands End. At 1200 this consolidated storm was 972 mb south of Fastnet Rock (fig. 52). There were reports of seas and swells of 25 to 43 ft as far away as

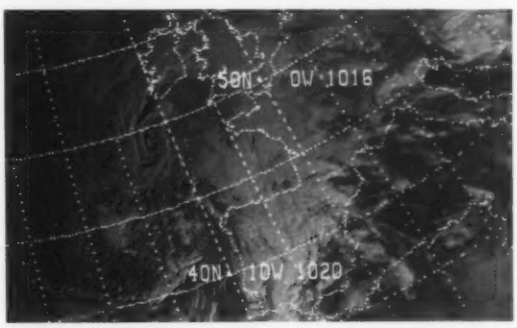


Figure 52.--At 1017 on the 7th NOAA's polar-orbiting satellite found the storm whirling around 49°N, 12°W.

900 mi southwest of the center. Winds were over 50 kn. On the 8th it brought winds of 50 to 60 kn and seas to 30 ft to the North Sea. On the 9th the storm was incorporated into a large deep storm that was approaching from the west.

This storm formed over the Red River Valley of Texas and Oklahoma on the 4th. Late on the 6th it moved off the East Coast near Cape Cod. By midday on the 7th, the storm was 970 mb over Cape Breton Island. The EXXON HOUSTON was headed for Norfolk into 50-kn winds and 20-ft seas. The CEDARBANK at 35°N, 70°W, was fighting 60-kn westerly winds and 33-ft swells.

On the chart of 1200 on the 8th a new center had formed east of the original one, and it was even more intense at 960 mb near 49°N, 48°W. The LAURENTIAN FOREST was south of the original center with 50-kn winds and 30-ft swells. Other ships reported 50- to 60-kn winds with smaller waves. The STOLT LLANDAFF was swamped by 39-ft swells near 44°N, 45°W (fig. 53). On the 9th the PROTSIONE (47°N, 42°W) was holding her bow into 60-kn northwesterlies. A ship reported a thunderstorm with 50-kn winds along a trough line, while another had 26-ft seas. The TANAFJORD (51°N, 44°W) contended with 60-kn winds and 30-ft seas. Ocean Stations Charlie and Romeo were tossed by seas up to 30 ft on the 10th.

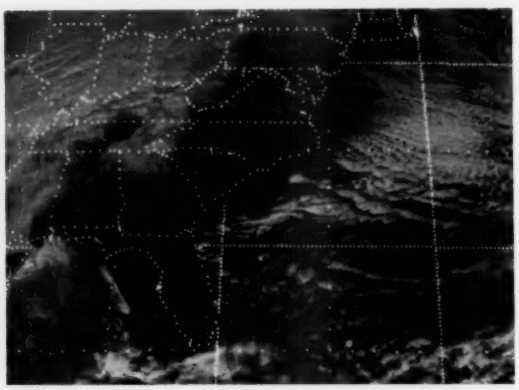


Figure 53.--The cold, dry air moving off the continent becomes very unstable and turbulent as it moves over the warmer ocean.

The storm was now moving toward the Faeroe Islands at 962 mb. The area on the charts south and west of the center was cluttered with sea and swell reports over 20 ft. The highest swell was 39 ft reported by the KORRIGAN about 850 mi southwest of the LOW. Winds of 60 kn were reported by the C.V. LIGHTNING. The center passed within a few miles of OWS Lima. On the 12th it was absorbed by another vicious storm.

Lake Huron was the spawning ground for this storm. Strong southerly winds were blowing off the U.S. East Coast by late on the 9th. At 1200 on the 10th the central pressure was 970 mb over Anticosti Island in the Gulf of St. Lawrence. A British ship experienced 50-kn winds with 36-ft seas near 41°N, 58°W, just east of the front, and a Canadian ship had 52-kn winds in the Gulf as she registered a pressure of 977 mb. As the storm moved over the Labrador Sea, it deepened to 955 mb on the 11th. A minus 5°C wind was blowing at 50 kn in the Strait of Belle Isle. Swells of 20 ft were reported along latitude 44°N from 60° to 30°W. A ship reported 60-kn winds and 25-ft seas near Sable Island. Later, the swell waves increased to 33 ft. On the 12th the LOW was approaching Kap Farvel. South of the center the RAVA RUSSKAYA encountered 50-kn winds and 38-ft swells. OWS Charlie measured 28-ft seas. By early on the 13th the swells had increased to 31 ft. Later that day the storm dissipated.

This storm tracked along the United States-Canadian border and moved out to sea near Portsmouth, N.H., on the 15th. It tracked along the coast, and at 0000 on the 16th the pressure was 986 mb. The CHEBUCTO (43°N, 65°W) was battered by 80-kn winds from the northwest. South of Newfoundland three ships reported winds near 50 kn with two measuring swell waves of 30 ft. On the 17th the LOW circled over Newfoundland as another center formed near 40°W. A ship found 23-ft swells between the two centers, which were rotating around each other on the 18th. The maximum wind appeared to be about 45 kn. When the chart of 0000 on the 19th was analyzed, only one 982-mb center could be found. The CHEVRON AMSTERDAM 600 mi south of the center near 36°N, 47°W, was sailing into 50-kn winds. On the 20th the circulation of the 968-mb LOW dominated the Atlantic from Iceland south to 25°N and from Newfoundland to Europe. Several ships had reported 50-kn winds with one swell report of 31 ft at 50°N, 45°W. The Soviet ship ARAGUI (40°N, 35°W) was pounded by 33-ft seas and 50-kn winds. North of the LOW, Icelandic fishing boats were fighting winds as high as 60 kn.

The LOW split into two centers on the 21st with the new one destined to become the primary center. The C.P. TRADER was caught near the center with 966-mb pressure, 45-kn winds, 25-ft seas, and 33-ft swells. Charlie was nearer the center with light winds at 965-mb pressure and 21-ft swells.

The storm consolidated again on the 22d as another storm moved around the southern perimeter. The DART AMERICA was stationary at 45°N, 37°W, with 50-kn winds, 21-ft seas, and 39-ft swells. The 966-mb LOW was still very close to Charlie with the 20-ft swells continuing. The LOW picked up speed on the 23d and disappeared on the 24th over the Norwegian Sea.

As far as the marine community is concerned this was an inland storm, except over near-shore waters. The LOW originated north of Hawaii along latitude 35°N on the 15th. It maintained its identity across the Rocky Mountains and intensified over the central Plains on the 19th. At 1200 on the 21st the storm was 1000 mb over Lake Michigan. Storm warnings for winds in the 50-kn category were posted for Lake Huron with gale warnings for the remainder of the Lakes. A second LOW formed over the Carolinas at the point of occlusion (fig. 54). Four ships foundered or sank in the Chesapeake Bay and along the Maryland-Virginia-North Carolina shoreline. Crews from three of the craft, tugboats towing barges, were rescued. The

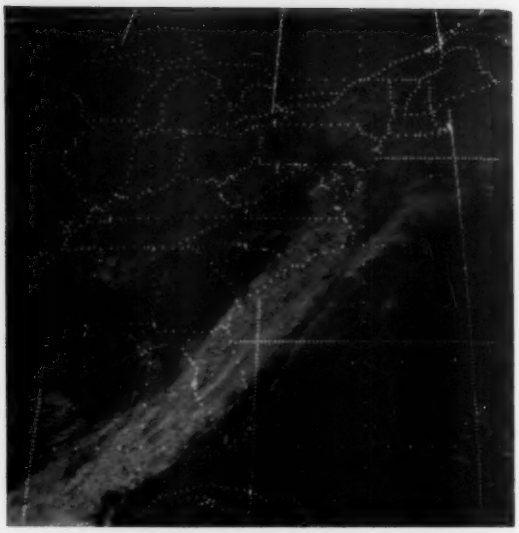


Figure 54.--The LOW over Michigan is not easily discernible, and only the beginning of the upper air circulation is apparent over Virginia and North Carolina at 1700 on the 21st.

tanker AEGIS PRESIDENT sprang a leak off Cape Henry. High seas battered resort centers along the Delmarva Peninsula. A newspaper reported seas as high as 60 ft. Four Navy ships returning to Norfolk from the Mediterranean were delayed a day in arrival owing to the severe seas. Late on the 22d the storm again consolidated into one center over James Bay and continued northward to Cornwallis Island.

Monster of the Month--This LOW developed over North Carolina on the 18th at the intersection of a complicated frontal system. It was also the LOW that rotated around the periphery of the storm described above and was the most southern of the significant storms. It paralleled 35°N to 30°W, where it turned northnortheastward.

At 1200 on the 19th, the 989-mb center was near 36°N, 71°W, with the strongest winds north of the center. Two ships within a degree of latitude of 39°N, 72°W, one was the CHEVRON ARNHEM, reported winds of 50 and 55 kn with seas as high as 26 ft. On the 20th, the tight gradient had expanded to the west side of the LOW, and the DILOMA was pounding into 60-kn winds and 33-ft waves. A ship reported a thunderstorm on the 0000 chart of the 21st, while not far away the JOANA had 68-kn winds out of the southwest. At 1800 the GREEN VALLEY was engulfed with 56-kn winds and 30-ft seas while 200 mi south of the LOW. The FRESNO CITY encountered heavy weather enroute to Balboa; deck cargo of lumber was partially lost. On the 22d the center was 990 mb at 35°N, 31°W. The SNOWLAND was 500 mi to the west-southwest with 31-ft seas. Closer to and more south of the center, 60-kn winds and 30-ft seas were reported by the WORTH.

When the storm turned northward on the 22d (fig. 55), it picked up speed and by 1200 on the 23d was 978 mb almost directly over Ocean Weather Station Romeo. Her winds were 40 kn and seas 20 ft. The SUN PRINCESS reported heavy weather damage on the 21st and 22d on arriving at Balboa on the 23d. The EXPORT COURIER had 60-kn winds and 18-ft seas near the

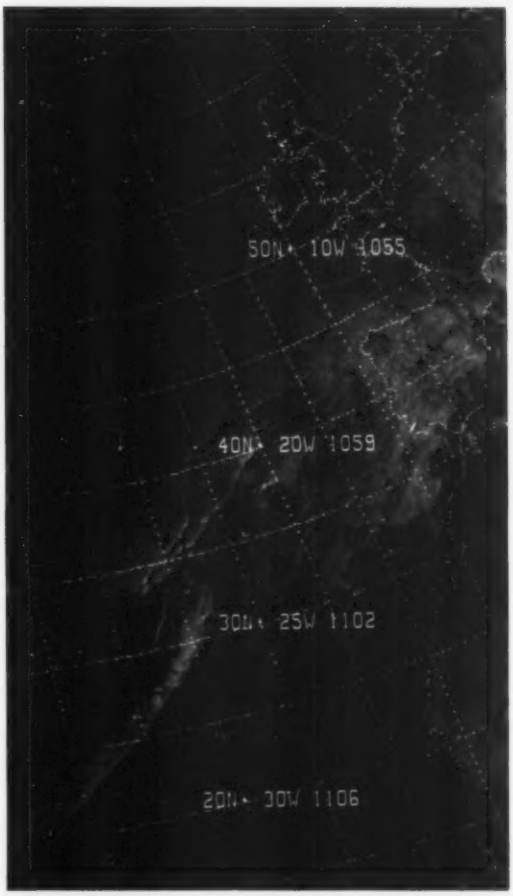


Figure 55.--In approximately 25 hr the storm raced from near 34°N, 32°W, to Ocean Weather Station Romeo.

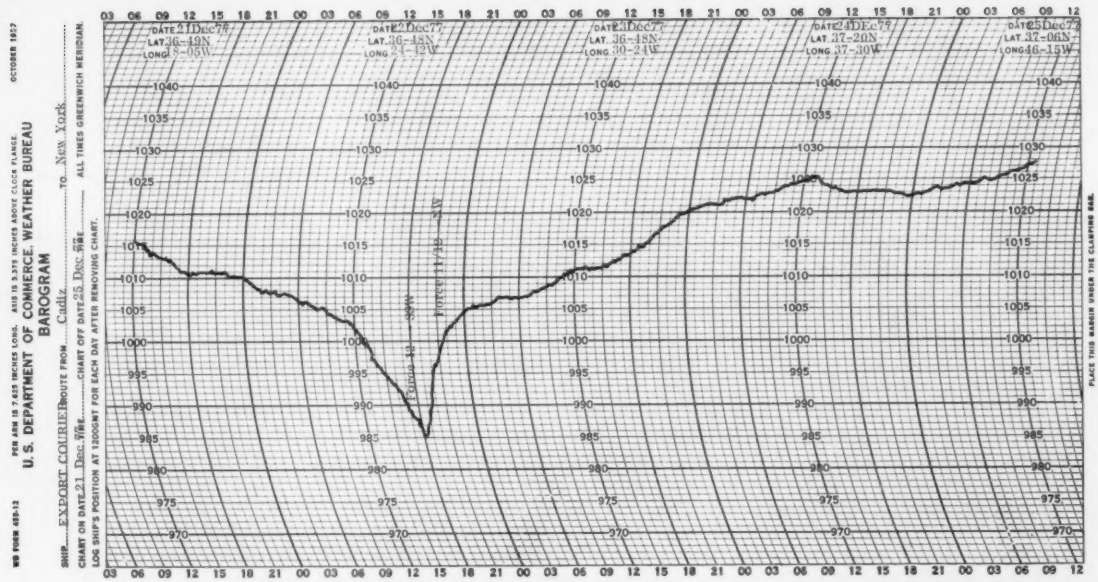

U. S. DEPARTMENT OF COMMERCE. WEATHER BUREAU
BAROGRAM
OCTOBER 1957
SHIP EXPORT COURIER ROUTE FROM Cadiz TO New York
CHART ON DATE 21 Dec 77 CHART OFF DATE 25 Dec 77
ALL TIMES GREENWICH MERIDIAN.
LOG SHIP'S POSITION AT 1200GMT FOR EACH DAY AFTER REMOVING CHART.
PLACE THIS MARGIN UNDER THE CLAMPING BAR.
DATE 21Dec77 LAT 36-49N LONG 7-05W
DATE 22Dec77 LAT 36-48N LONG 21-12W
DATE 23Dec77 LAT 36-48N LONG 30-24W
DATE 24Dec77 LAT 37-20N LONG 37-30W
DATE 25Dec77 LAT 37-06N LONG 46-15W
FORCE 12 SW
FORCE 12 SW

Figure 56.--The pressure recorded by the EXPORT COURIER dropped to 985 mb with force 12 winds shifting from south-southwest to northwest.

Azores (fig. 56). Later in the day the BREMERHAVEN, not long out of the English Channel, was sailing southwestward into 60-kn winds and 26-ft waves. On the 24th the storm moved over the North Sea bringing 50- to 60-kn winds to that body of water. The Belgian tank ship LAGUANA rammed a breakwater in high winds and sank with the loss of a woman and three children. As hurricane-force winds lashed the coasts of England, Ireland, Holland, and Denmark, six people drowned in the churning seas, and seven more were feared to have drowned. The 500-ton LADY KAMILLA sank off southwest England. The 3,500-ton EAST BIRD II went adrift off Wales, and the 2,440-ton RAFAELA went aground off the east coast. Many trees were uprooted with extensive property damage. Devon reported 87-kn gusts and London had 65 kn. The storm moved into western Russia on the 25th.

A description of good weather in December for a change! A cell of the Bermuda-Azores High off the southeast coast of the United States started drifting northeastward on the 23d. It increased in pressure as it moved, and by the 26th it was the primary high-pressure center over the North Atlantic. On the 26th the central pressure exceeded 1040 mb, and by the 28th it was analyzed at 1051 mb near 47°N, 33°W. The WALTER ULBRICHT reported the highest pressure of 1049.8 mb at 0000 on the 28th near 48°N, 31°W, with a 10-kn northerly wind. The 1050-mb center was analyzed a few miles west of that position. LOWs were being deflected northward off the East Coast or were over the Greenland Sea. It was the 31st before the pressure dropped below 1040 mb. This brought good weather for a large portion of the North Atlantic and the major shipping lanes during the last week of the month. Accurate climatological records for high-pressure records over the oceans could not be found; but this probably approaches the record over the ocean, where the pressure does not get as high as it does over the continents. The highest pressure for the world is 1083.8 in Siberia, and for the United States it is 1063.6 in Montana.

This was one of the storms which the high pressure kept far to the north. It formed on the Greenland coast near Scoresby Sound (70°N) on the 28th and moved eastward. At 1200 on the 29th it was near 70°N, 03°E, at 960 mb. Winds of 40 kn were measured on the east coast of Iceland. Fishing vessels around the island were reporting 50-kn winds and 20-ft seas. The northwesterly flow covered the North Sea and the United Kingdom. Late on the 30th various vessels and platforms in the North Sea were reporting winds up to 60 kn and seas to 36 ft. On the 31st the ZARIA took the award for 38-ft seas near 56°N, 01°E. By late in the day the LOW had crossed the Baltic Sea and was heading inland.

Casualties--The roll on-roll off vessel JASMINE developed an extreme list in heavy seas 40 mi off Haifa on the 9th and returned to Haifa on the 13th. It was reported that the 109,522-ton British tanker E. HORNSBY WASSON sustained minor heavy weather damage on the 12th while on a voyage to the Bahamas. On the 18th the 5,921-ton Danish HETLAND RANGER suffered slight damage as did the pier while unmooring in strong winds in Nova Scotia.

The 12,039-ton British MANCHESTER CRUSADE encountered heavy weather during passage to Montreal December 9 to 16. The American Great Lakes bulkcarriers GEORGE D. GOBLE and the Canadian GODERICH became stuck in ice on the 11th in the outer channel to the Detroit River. The 8,798-ton

bulkcarrier HENRY FORD II became stuck in ice while 1 mi below Detroit River Light on the 21st. The cargo vessel ROMAN PAZINSKI, Europe to East Coast, lost containers overboard.

This was either a South Atlantic or an Indian Ocean accident. In what may have been the costliest collision to date, the two sister ships VENOIL and VENPET (both over 330,000 tons) collided about 80 mi south of Port Elizabeth. There was a report of fog in the area. The VENOIL was laden with over 75 million gal of crude oil, and the VENPET was in ballast. Both ships caught fire and were abandoned by the crews. Eighty-four of the 86 crewmembers were saved by nearby vessels and a helicopter. The fires were extinguished and both vessels taken in tow.

ROUGH LOG, JANUARY 1978--There were fewer storms this month than normal. If wind were the only criterion, there would have been fewer storms to write about, but the winds produced high swell waves owing to long fetches. There were at least three storms that qualified for the monster of the month. The tracks were shifted northward and westward from climatology. The primary path of the centers was over and along the United States-Canadian east coast to the Denmark Strait where many dissipated. This was partially because of the influence of a higher-than-normal Azores High centered farther north than usual.

The Azores High was the prominent feature over the North Atlantic on the mean sea-level pressure charts. It was 1031 mb near 38°N, 30°W, compared to 1020 mb near 30°N, 20°W, according to climatology. The Icelandic Low was deeper than usual at 994 mb near 62°N, 32°W. This was 7 mb lower than normal and about 150 mi northeast of the normal position.

The higher pressure and northerly location of the Azores High produced a large positive anomaly center of 15 mb near 41°N, 32°W. The ocean area from coast to coast and latitudes 20° to 55°N was under the influence of this positive anomaly center. The major negative anomaly had an 8-mb center that covered the area between Iceland and Greenland plus the ice cap.

The upper air gradient was also more intense than usual with a low center over Baffin Island and a high center south of the Azores. A very sharp trough paralleled the U.S. East Coast near the position of the Appalachian Mountains. The zonal flow then traveled northeastward toward northern Europe. The same large area of positive anomaly dominated that part of the ocean of major interest to shipping.

Extratropical Cyclones--A LOW had moved northeastward up the North American east coast. On the 2d it was south of Newfoundland. Another center formed to the southwest in a weak trough trailing the LOW. The second center quickly developed and on the 3d was the primary storm. The MORMACSUN was east of Hatteras headed toward New York with 20-ft seas on her bow. The CETRA CARINA (39°N, 50°W) was fighting 60-kn southerly winds. Later in the day a ship near 45°N, 44°W, had 25-ft seas with a thunderstorm along the front. At 1800 the BRONISLAW LACHOWICZ near 39°N, 69°W, south of Nantucket Island reported 72-kn west-northwesterly winds. At 0000 on the 4th, the 960-mb LOW was near 55°N, 53°W. At noon the CETRA CARINA had 50-kn winds on her starboard. Not far away a ship found 20-ft swells.

The storm was heading for Kap Farvel, but on the 5th it turned southeastward as a small LOW moved along that side. Three Soviet ships in the Labrador Sea reported northerly 50-kn winds with 30-ft seas. At 1200 the INDIGUIRKA near 56°N, 47°W, had 55-kn winds and 28-ft seas on her starboard quarter. A ship south of the center was pounding into 30-ft swells.

On the chart of the 6th, the new low center became the primary center west of Iceland at 967 mb. Seas and swells of 20 ft were still being observed along 55°N. On the 7th the storm was over the Greenland Sea.

Monster of the Month--On the 8th a polar front with a frontal wave lay across the southern states with a weaker arctic front across the northern states. A large 1053-mb HIGH was over western Canada feeding very cold air over the eastern half of the United States. This cold-air push rapidly drove the arctic front southward with cyclogenesis over Lake Huron. By 1200 on the 9th a 975-mb LOW was near Ottawa with strong southerly flow off the East Coast (fig. 57).

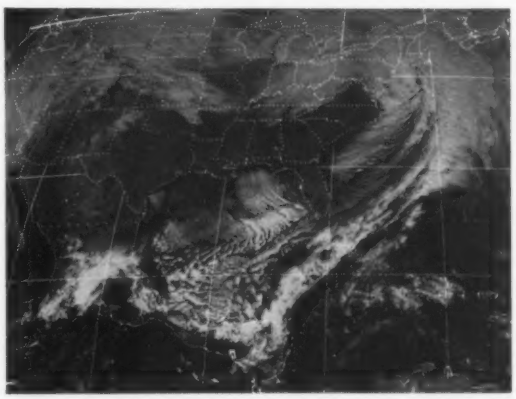


Figure 57.--The cold air indicated by cloud streets can be seen pouring off the East and Gulf coasts. Heavy clouds with snow cover the United States and Canada from the Ohio River Valley northward.

This was one of the worst storms for the eastern United States this year. Strong cold winds drove the wind-chill temperature to as low as minus 48°F at Chicago. Actual overnight lows of minus 20° to 30°F

Figure 58.--High seas and surf pounded the U.S. East Coast. Here, high water ravages the lobster pound at Lincolnville, Maine. Wide World Photo.

were common in the Plains States. Temperatures dropped into the 30's in southern Florida. In Ohio and Cleveland National Guardsmen were called out to rescue stranded motorists. There were power outages and shortages in many areas. Ships and coastal areas all along the East Coast had problems (fig. 58). On Narragansett Bay of Rhode Island 60 families were evacuated. In Portland, Maine, the family that manned the light station at Goat Island was forced out by rising water.

The U.S. Coast Guard cutter PT. JACKSON encountered 10-ft seas with winds gusting to 70 kn off Massachusetts while towing the disabled dragger ZIBET. Bridges and wharves were destroyed. Many ships and barges had problems. The 24,471-ton tanker ACHILLES ran aground in Narragansett Bay. The barge BOUCHARD 100 with 27,000 barrels of fuel sprang a leak in Huntington Bay, Long Island. Efforts to contain the leak were hampered by 10-ft waves and severe winds. The tanker TULSA GETTY dragged anchor and grounded in Delaware Bay. High tides caused severe damage all along the coast. The tug ROYAL LADY capsized and sank in Port Royal Sound, S.C., while pushing barges. One crewmember of four survived.

The KING RICHARD was sailing southeastward near 35°N, 72°W, into 54-kn southerly winds driving 31-ft seas and 26-ft swells with a thunderstorm. There were many reports of winds of 50 kn or greater on the 10th as the 956-mb storm moved northward. A ship near 38°N, 65°W, reported 41-ft seas. On the 11th the LOW was over Davis Strait, but there were still 25-ft swells as far south as latitude 35°N. High pressure centered near 45°N blocked easterly movement of the storm. Two French ships, the CETRA CARINA (39°N, 64°W) and PENHIR (39°N, 50°W), caught 64- and 54-kn winds. On the 13th the storm died near Thule.

As the first storm of the month moved into the Greenland Sea on the 7th, a LOW formed near the southeastern coast of Greenland. It remained stationary until the 9th, when it started an easterly movement. Seas and swells of 20 to 25 ft were reported generally south of Ocean Weather Stations Charlie and Lima. On the 10th the 982-mb center was between Iceland and the Faeroe Islands. OWS Lima measured 45-kn winds and 26-ft swells. At this time the center turned southward over the North Sea. The Azores High persisted near 40°N, 30°W (fig. 59). The KHIBINSKIE GORY had 50-kn

Figure 59.--The anticyclonic circulation around the 1035-mb Azores High is illustrated in this NOAA polar-orbiting satellite image.

Figure 60.--A 150-yr-old pier was destroyed at Margate, England, by the wind-driven high seas and surf. The lifeboat station was isolated by the high water. Wide World Photo.

Figure 61.--A dredge lies on her side at Dieppe, France, capsized by the high winds gusting to 65 kn. Wide World Photo .

winds and 20-ft seas near 47°N, 11°W, while Ocean Weather Station Romeo to the west near 17°W had 26-ft seas. The STRATHASLAK south of Bishop Rock was pounded by 50-kn winds, 25-ft seas, and 36-ft swells. The LNG tanker ARIES broke adrift from her moorings at Canvey Island in storm-force winds at flood tide late on the 11th (fig. 60). She dragged anchor and moorings causing four barges to set adrift with one capsizing. A dredge capsized at Dieppe, France (fig. 61). One of the two men aboard drowned. Winds gusted to over 65 kn. Romeo continued with 25-ft seas into the 12th. The HIGH was pushing northward with a ridge extending into the Greenland Sea. As the LOW moved into Germany, the center jumped the Alps to reform over the Ligurian Sea.

Even though the LOW was now over the Mediterranean, there were still strong north to northeasterly winds over the North Sea as the HIGH was now 1042 mb near 49°N, 19°W. These strong winds caused the 3,000-ton Swedish freighter FENIX to shift cargo and develop a 30° list while north of the Dutch island of Terschelling. Also, the 9,326-ton Greek freighter TANAGREA had weather problems 20 mi south of Umuiden. The Panamanian freighter EASTERN UNITY (9,505 tons) requested assistance near Cherbourg, and the 21,050-ton Greek AEGIS BALTIC went aground in the Scheldt but was later refloated.

This was really a coastwise storm. It developed on the 12th off Brownsville, Tex., and followed the coast to Labrador, Canada, on the 16th. When the 994-mb storm was near Atlantic City on the 14th, a SHIP near 36°N, 71°W, was battered by 41-ft seas (fig. 62). The persistent Azores High, centered between the Azores and Newfoundland, blocked eastward movement of the storm as it followed a northeasterly track to Kap Farvel. The SEEADLER was 15° latitude south of the LOW with 55-kn winds and 25-ft waves. Late on the 17th the JOHN CABOT (51°N, 53°W) had 60-kn winds. As the LOW moved south of Iceland on the 18th and 19th, wave reports of 25 ft were common between 45° and 55°N. Romeo measured 33-ft waves on the 19th

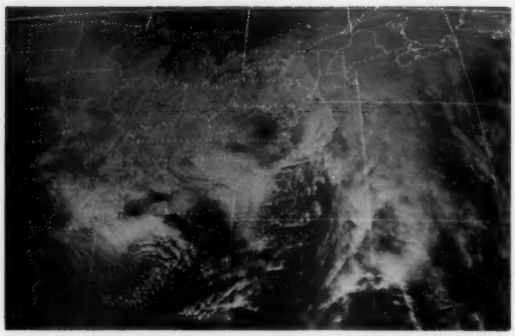


Figure 62.--The surface low center is obscured by the clouds around the upper air center, which was farther west.

with 50-kn winds. The 15,351-ton French ATLANTIC COGNAC, Southhampton for New York, arrived Brest on the 20th for deck repairs from heavy weather damage. A French ship had 50-kn winds, 30-ft seas, and 33-ft swells off Fastnet Rock. The GORNY SLASK reported 85-kn winds, 23-ft seas, and 25-ft swells with thunderstorms in the Bay of Biscay. On the 20th Romeo had 39-ft seas and Lima 20-ft seas with 34-ft swells. Another LOW had developed to the southeast, which moved over the United Kingdom and dissipated.

The Azores High was still sitting firmly over the central ocean, when a cyclone formed over the Carolinas on the 18th. The LOW moved up the Atlantic coast and was 992 mb over St. John's at 1200 on the 19th. Ship reports indicated only gales. Twenty-four hours later it was 964 mb southeast of Kap Farvel. Three ships along the trailing front reported 23-ft seas and/or swells with gales. On the 21st the 956-mb LOW had turned toward Kap Farvel. The SELFOSS as well as several other Icelandic ships reported 50- to 60-kn winds. Ocean Weather Station Romeo again had seas of 26 ft, while Charlie suffered 23 ft. Other ships south and west of them were reporting the same. The LOW stalled near the Greenland coast, where it slowly filled. Several frontal waves moved around the southern periphery. One brought 60-kn winds and 25-ft waves to the DELTA DRECHT near 47°N, 24°W. Not far away the C.P. DISCOVERER was sailing into 33-ft swells. The LOW disappeared late on the 23d.

This was a Gulf Coast storm, but it tracked inland on the west side of the Appalachian Mountains. By the 26th its circulation reached across the mountains to the Gulf Stream (fig. 63). A weather forecaster in Massachusetts reported that the temperature rose 18°F in just a few minutes. A ship heading south near Cape Hatteras plotted 51-ft seas. The Coast Guard cutter HAMILTON reported 65-kn winds near 40°N, 72°W. After the storm center passed over the Great Lakes, two centers formed on the 27th with the easterly one surviving. In the early morning on the 27th,

Figure 63.--The U.S. Navy helicopter-carrier SAIPAN at Norfolk, Va., broke all of its mooring lines except one in the high winds. Here, tugs nudge the huge ship back to its dock after the carrier damaged the pier in the foreground. Wide World Photo.

a tornado hit Stafford County, Va., killing a young boy and damaging many houses and trailers. Rain and melting snow caused rivers to flood in the East. In the Midwest snowfalls of 7 to 17 in with winds gusting to 70 mi/h brought snow drifts in Ohio and Indiana of 5 to 6 ft. A passenger train in Indiana was stranded in a snow bank for more than 12 hr. In Ohio 150,000 people were without power and heat, and more than 5,700 motorists were rescued from stranded vehicles with over 2,000 beyond reach. The BURTON AYERS on Lake Erie and set in ice off Peele Passage measured 98-kn winds at 1200 on the 26th. An automated station at the Cleveland Crib recorded 89 kn, and a bridge near the harbor was blown down.

All-time low-pressure records were broken (fig. 64). Cleveland, Ohio, recorded the lowest of 28.28 in (957.7 mb). Detroit, Mich., and Erie, Pa., had 28.34 in (959.7 mb); and Columbus, Ohio, recorded 28.47 in (964.1 mb). On the 27th storm warnings were still posted for the Lakes.

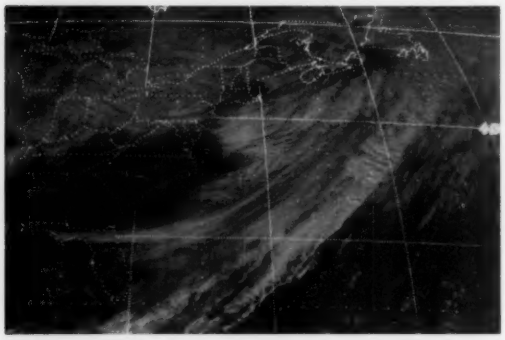


Figure 64.--On the 27th the storm has moved northeastward over Canada bringing cold snowy weather to the eastern third of the Nation.

A ship off Cape Hatteras had 24-ft seas on the 27th. A few hours later another ship verified that report. Late on the 28th the LOW moved over the Labrador Sea. The HUDSON was off Hamilton Inlet with 50-kn winds. On the 29th the LOW broke up on Kap Farvel.

A frontal wave moving across the top of the HIGH developed into a LOW on the 26th. As it moved eastward, another center formed at the point of occlusion off Ireland on the 27th. Since there was a circulation already established, it developed quickly. At 1200 OWS Romeo had 30-ft seas, and at 0000 on the 28th they were 39 ft (fig. 65). A ship coming out of the English Channel fought 60-kn winds. The HANNOVER was off Brest with 52-kn winds and 33-ft seas and swells. The storm was over the English Channel on the 29th, and many ships were reporting 50 to 60 kn. Coastal weather stations were measuring 40-kn prevailing winds. On the 30th the storm moved over Scandinavia.

This storm wrecked havoc in Europe from the Riveria to Scotland. Six persons died and 30 were missing and believed drowned as weekend blizzards, gales, heavy snow, and rain brought chaos to the area. Avalanches and snow slides took three lives. One man died in northern Ireland, when strong winds blew him off his feet and into the water. In north Wales a climber drowned in a mountain lake after slipping. In Italy a bridge collapsed, and three were drowned when their car plunged into the river. In Yugoslavia powerlines were blown down, and winds along the coast caused mountainous seas which sent spray soaring 20 m into the air as the seas pounded the cliffs. Along the Riviera gale-force winds, rain, and snow blocked train tracks and highways. Rain, wind, and tides flooded Venice. Spanish officials feared that 27 crewmembers of a 36-man crew of a trawler were drowned. The 1,317-ton MARBEL ran aground off Vigo when caught by 55-kn winds.

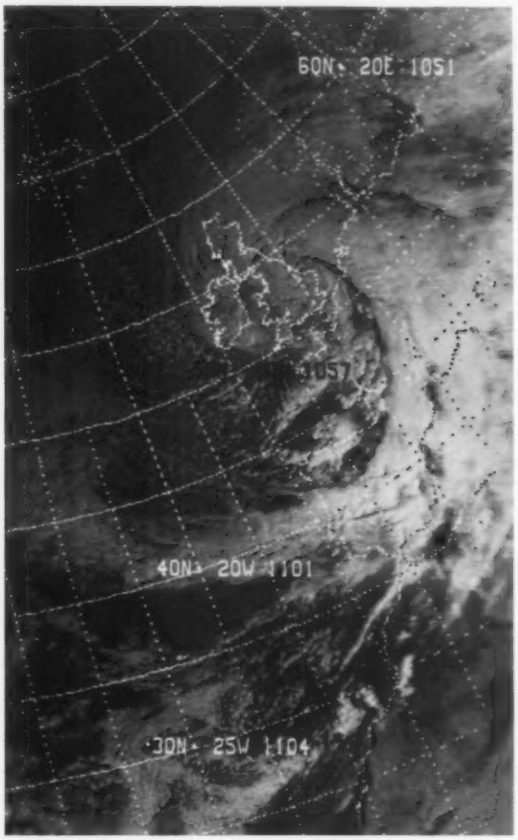


Figure 65.--The vicious storm is centered over the United Kingdom on the 28th. High winds and seas were battering coastal areas and ships at sea.

Casualties--The 4,226-ton Panamanian LESLIE B. radioed the Coast Guard at Halifax on the 2d that she was taking on water from heavy seas and in danger of sinking. Four additional dewatering pumps were delivered to control the flooding. The 10,029-ton Turkish KOYCEGIZ arrived New Orleans from the Mediterranean on the 2d with heavy weather damage.

The Singapore freighter SAVANNAH (8,893 tons) was adrift in bad weather with engine trouble on the 4th off Algiers. The Liberian cargo vessel NANFRI (19, 226 tons) reported heavy weather damage upon arrival at Genoa on the 4th. The 9,190-ton GREGOS arrived Durban from Trinidad with heavy weather damage on the 9th.

The Liberian-registered cargo vessel MAIRA (9,483 tons) arrived Algiers on the 9th with several containers lost when they shifted in heavy weather. The lash barge PL-1-0531 sank near Bandirma jetty in Turkey,when it was caught in a sudden storm and the holds flooded. The American hydrofoil FLYING PRINCESS collided with the motor tank barge DUTCH COURAGE in dense fog while enroute to London on the 18th.

The British tanker SILVERPELERIN (4,474 tons) arrived Nova Scotia on the 18th with heavy weather damage incurred on the 15th. The 30,000-ton laker JAMES R. BARKER arrived Chicago with self-unloading equipment damaged, which was probably caused by frozen ore. The Greek steamer TOLMIDIS (9,481 tons) reported taking on water and was abandoned by the crew about 60 mi off the coast of North Carolina on the 22d. The SEA-LAND RESOURCE was surveyed at Rozenburg on January 4 for heavy weather damage in December.

Rivers in the Midwest were generally frozen except for large ice floes which would break loose and hinder navigation. Late in the month huge ice floes broke loose above the Markland Dam in the Ohio River. Seventeen barges broke loose above the dam and sank the tug CLARE E. BEATTY (fig. 66). A submerged ice floe tipped the tugboat's bow 35 ft above the water, and she was crushed by a 300-ft by 52-ft barge. Five barges were piled against the McAlpine Dam, and 12 barges and an entire marina of boats were heading for the Connelton Dam. A 50-mi section of the Ohio River along Indiana and Kentucky was closed because of one giant ice floe with about 40 ft showing above the waterline.

Figure 66.--The Ohio River tug CLAIRE BEATTY sits atop a large ice floe jammed against the Markland Dam. Later, a large barge also trapped in the ice crushed and sank her. Wide World Photo.

Rough Log, North Pacific Weather

December 1977 and January 1978

ROUGH LOG, DECEMBER 1977--The North Pacific had the usual density of storm tracks this month. They did not follow the climatological paths very well. The usual track from northern Honshu did not curve northward as quickly as usual; therefore, the path was over the central rather than the western Bering Sea. A less dense track east of the Japanese islands curved northward to join the Bering Sea track. Another track originated near the Date Line between latitudes 35° and 40°N and headed toward the Queen Charlotte Islands. Several storms formed off the coast of California, and three of them reached the coast.

The Aleutian Low was split into two centers as climatology indicates, but the primary centers were reversed, and they were not as deep as their counterparts. The primary center was 1003 mb near 51°N, 166°E, about 400 mi east of Mys Lopatka. The other center at 1007 mb was about 600 mi west of Seattle. A strong high-pressure center (1025 mb) was near Great Slave Lake in Canada. The Pacific High, which normally has a thin east-west configuration, was even more so this month. Its central pressure was slightly weaker, so the north-south gradient was much less than normal.

Surprisingly, the major anomaly center was plus 10 mb over western Alaska. Its pattern stretched into northwestern Canada, where there was another plus 8-mb center. The largest negative center was 6 mb about midway between Hawaii and Seattle.

The upper air pattern was more organized than the surface. The height centers were less than their climatic counterparts with a weaker gradient and, therefore, winds. One significant difference from the climatic pattern was a pronounced ridge on the west coast

of Alaska.

The last tropical cyclone of the season, typhoon Mary, developed late in the month and lasted into the New Year.

Extratropical Cyclones--This LOW actually formed in late November but did appear to be significant. However, on December 1 the WEST OCEAN was over 400 mi north of the center with heavy rain, 50-kn winds, and 30-ft swells. Twelve hours later the center had jumped to 43°N, 154°W, at 987 mb, and the WEST OCEAN now reported 33-ft seas and 39-ft swells with 60-kn winds. On the 2d two ships reported 23-ft waves. By the 3d the storm was over Queen Charlotte Sound and crossing the mountains.

This LOW originated off Tokyo on the 1st. By 1200 on the 2d it was a large 986-mb circular storm. The SEA-LAND COMMERCE was caught near 43°N, 156°E, with wretching 70-kn winds and 33-ft seas and swells. Two other ships south and east of the center battled 33-ft swells.

As the storm moved northeastward, it was 964 mb near 46°N, 160°E, at 1200 on the 3d (fig. 67). Four ships had winds over 50 kn. One ship 700 mi to the south bounced on 32-ft swells. There was no let up until midday on the 4th, when a LOW broke off the east side of the circulation, and the main storm turned northwestward. Even so, a ship downstream reported 45-kn gales and 23-ft swells. The storm moved over the Sea of Okhotsk, where it remained stationary for over 60 hr.

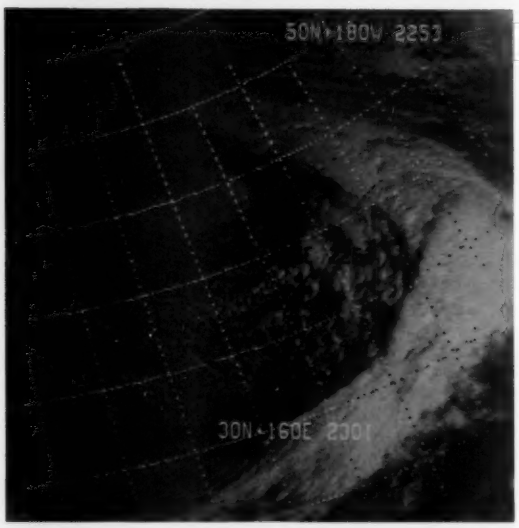


Figure 67.--At this time the LOW is centered near 48°N, 160°E. The ship with the high swell waves had only scattered clouds.

This was the LOW that broke away from the one above. At 0000 on the 6th, it was 986 mb near 41°N, 173°W. The PANASIA was 400 mi northwest of the center with 20-ft seas and 32-ft swells. On the 0000 chart of the 7th the LOW had split into three centers. The FED-STEEL was north of the centers (49°N, 156°W) with 60-kn winds and 15-ft waves, which increased to 30 ft 6 hr later. On the 8th another new center appeared 6° latitude north of the other centers and moved westward. A 1054-mb HIGH was over the Yukon Territory and this tightened the gradient between the two with increased windspeeds. A SHIP reported 55-kn winds and 33-ft swells plus heavy rain. South of the center the highest wave report was 25 ft (fig. 68).

This storm and another LOW moving eastward and to the south were rotating around a center between them. The buoy 46003 (formerly 46017) reported 26-ft waves. The GOLDEN BEAR (48°N, 161°W) was sailing into 54-kn winds while at 54°N, and the PRESIDENT MADISON had 50-kn easterlies on her stern. The buoy was still being rocked by 25-ft waves. The western LOW dissipated on the 10th, while the second one continued to the coast of British Columbia where it died.

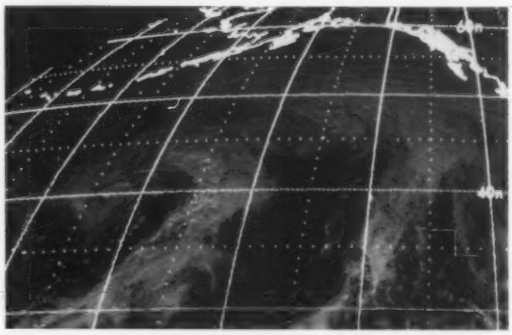


Figure 68.--Later in the day the primary LOW was at 40°N, 164°W, and the two secondary LOWs were near 50°N, 165°W, and 46°N, 145°W. Note the striations in the stable clouds over the Gulf of Alaska south of the HIGH.

This storm developed east of northern Honshu on the 8th. On the 9th it was creating gale-force winds. It passed north of the ASIA INDUSTRY on the 10th at 978 mb pounding her with 25-ft waves. The SHIMA MARU was north of the center with 50-kn winds which continued most of the day. The ASIA INDUSTRY was keeping pace with the storm as she was pushed by 60-kn winds and swells of 40 ft. Another ship about 200 mi to the southwest had 33-ft seas. At 1200 on the 11th, the 976-mb storm was near 39°N, 172°E (fig. 69). The SEA-LAND EXCHANGE passed south of the

Figure 69.--This circular storm looks like a coiled spring, and ships in its vicinity probably thought it broke while fully wound.

center and found 40-kn winds with 25-ft seas and swells in the southwest quadrant. The FEDSTEEL was now in the vicinity of this storm with 60-kn easterlies on the 12th. The ASIA INDUSTRY also kept up her speed with 50-kn winds on her stern and 40-ft swells. At 0900 the ANCO DUKE was stationary and riding 30-ft seas.

The main feature of this storm was high waves in the southern sector, where the winds had a long westerly fetch over a period of time. The KOREAN PEARL was along 29°N at 176°E with 65-kn winds. Swells of 25 to 33 ft were numerous as far south as latitude 25°N. Late on the 13th the center disappeared as part of the overall circulation.

The storm that took over the main cyclonic circulation formed on the occlusion of the storm above on the 11th. It moved ahead of the other center, gradually becoming the primary storm. By 1200 on the 14th the 946-mb maelstrom was in the Gulf of Alaska. A ship west of the center had 55-kn northerly winds. Later in the day the SAKHALIN (58°N, 150°W) had 50-kn winds and 33-ft seas. The LOW remained stationary for 12 hr and early on the 15th was 944 mb. Storm warnings for strong winds were posted for the Pacific coast from Point Arena, Ca., northward. Gusts of 70 kn were measured along the Oregon coast. A ship 600 mi southwest of the center had 31-ft swells. The winds were blowing at 50 kn or more. On the 16th the storm was weakening rapidly and remained essentially stationary over the upper Gulf of Alaska. It disappeared on the 19th.

This writeup describes a combination of several LOWs, some of which were quite short-lived. A large dumbbell-shaped HIGH stretched east to west from the Japanese coast. It slowly drifted eastward. On the 16th a LOW moved northeastward out of the Sea of Japan. As the southerly flow on the east side pushed against the slow-moving HIGH, the winds picked up to gale force. A Japanese ship was sailing northeastward with 23-ft seas near 38°N, 147°E. On the next chart another ship found 25-ft waves near 39°N, 150°E, and near 34°N, 146°E, the waves were 28 ft all along the front. On the 17th the storm was moving up the Kurile Islands chain.

The 1036-mb HIGH was over the central ocean at 40°N, 175°W, on the 18th. North of the HIGH on the south side of another LOW, there were two ship reports of 20-ft waves. On the north side of another LOW south of the HIGH, a ship had 40-kn winds and 23-ft waves. On the 19th a ship west of St. Paul Island had 20-ft seas. There were four low-pressure centers rotating clockwise around the HIGH on the 20th. The southern one was now west of the 1034-mb center, and the PRESIDENT EISENHOWER was between the two near 38°N, 177°W, with 39-ft swells. To the south along a front the ATLANTIC HIGHWAY had taken a wrong turn on the freeway and was involved in 23-ft waves. On the east side of the HIGH there were six high-wave reports between 27° and 45°N between longitude 145° and 150°W (fig. 70). Three of these were for 30-ft swells. On the east side of the LOW the EXXON NEW ORLEANS fought 55-kn winds and 34-ft swells.

On the 21st the northern LOW disappeared over the Chukchi Sea. The two LOWs east and west of the

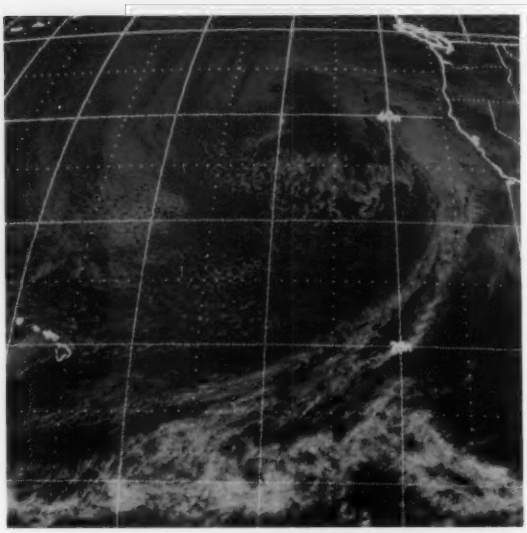


Figure 70. -- The high waves were associated with an unstable northerly flow on the east side of the HIGH. The cellular cloud pattern indicates high instability.

HIGH were increasing in intensity and area, while squeezing the HIGH out of existence. A new center developed in the eastern LOW and moved northward. The HAWAIIAN LEGISLATOR was sailing toward California near 27°N, 138°W, with 48-ft swells. The next day three ships south and west of the LOW reported 21- to 30-ft waves. The HIGH had now slipped far south to latitude 28°N. On the 23d all the cyclones were losing their energy and of little concern.

As the western LOWs described above chewed away at the HIGH and moved northward, there was an area of flat gradient to the west. On the 22d an incipient LOW was analyzed near 45°N, 158°E. It increased its energy and on the 23d had a broad circulation south of the center. Waves of 20 ft were not uncommon, and one ship had 26-ft swells near the front. On the 24th the LOW absorbed two other centers and was 982 mb near 53°N, 177°E. At 0000 on the 25th the JAPAN RAINBOW was presented with 60-kn winds near 49°N, 164°E. Late that day the LOW disappeared over the Bering Sea.

A LOW over Manchuria started moving eastward on the 23d. As it moved over the Kuroshio Current, it gained strength. On Christmas Day two ships had 50-kn winds near 34°N, 149°E. By 1200 on the 26th the 952-mb LOW was near 52.5°N, 167°E. There were many ships reporting winds over 50 kn. The highest wind report was received from the TRIUMPH near 46°N, 157°E. She had 66-kn winds and 33-ft waves. The DAIKEI MARU (40°N, 173°E) was sailing southward at the point of occlusion into 57-kn southerly winds, 20-ft seas, and 49-ft swells. A Japanese ship reported a low pressure of 953 mb almost in the center of the LOW. On the 0000 chart of the 27th the LOW was 946 mb. There were eight reports of winds 50 kn or greater. The highest was 62 kn by the

SHINZUI MARU at 47°N, 169°E. There were no wave reports, but 6 hr later the waves were 39 ft. The MONTIGNY had 25-ft seas and 36-ft swells at 53°N, 176°W. At this time the influence of the storm extended from Asia to Bristol Bay and the Bering Strait to 30°N. On the 28th the reported winds were not as high, but there were two reports of 33-ft swells north of the Rat Islands (fig. 71). The Russian cargo vessel KAPITAN MILOVZOROV reported heavy weather damage with loss of containers overboard. On the 29th she reported rolling to 49° with additional containers overboard and the loss of two cargo derricks. It was later determined that 50 40-ft containers were lost. The LOW stalled near 59°N, 173°E, until the 31st. On the 29th a secondary LOW, moving northward on the east side of the primary circulation, passed near St. Paul Island, which had 56-kn winds with gusts to 72 kn.

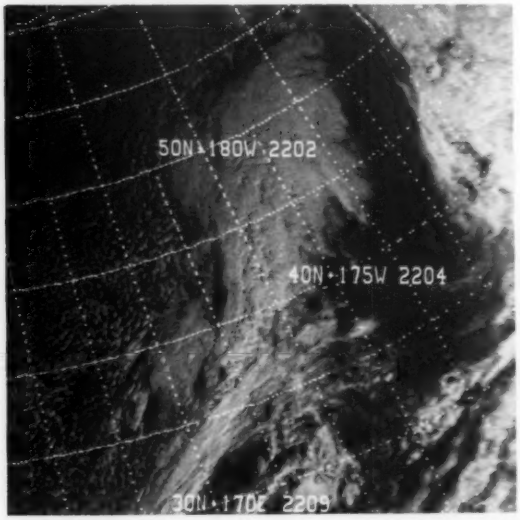


Figure 71.--The large LOW cannot be seen because of the low Sun angle. The large, bright cloud mass is associated with a secondary cyclone.

A short-wave trough developed on the 28th on the west side of the previously described LOW. By 1200 on the 29th, a 998-mb center had formed. The storm moved eastward and was 978 mb near 49°N, 164°E, at 1200 on the 30th. Ostrov Urup measured 45-kn winds. Ships off Hokkaido were reporting 50-kn winds. On the 31st the OJI GLORIA fought 55-kn freezing winds off Mys Lopatka. Later in the day there were waves of 28 ft reported in the same area. A ship reported seas of 39 ft south of the Near Islands. On January 1 the ship had moved only slightly as the winds increased to 60 kn with 36-ft seas and 39-ft swells. The storm crossed the Date Line very late on the 31st. It was now weakening, and on January 1 another LOW adopted the circulation.

This LOW just barely made the month and year. It was first analyzed northeast of Tokyo on the 1200 chart of the 31st. On New Year's Day a ship near the center had 23-ft swells with a thunderstorm and hail. On the 2d, the LJUTOMER (44°N, 177°E) slightly north and east of the warm front was pounded by 44-ft swells from the southeast. The LOW had turned northward and was 968-mb near 55°N, 173°E. A British ship 650 mi southwest of the center had 50-kn winds and 33-ft waves. In the southeastern quadrant a ship had 46-ft swells near 42°N, 174°W, and another had 49-ft swells near 38°N, 174°E. At 1200 on the 3d, Adak Island measured 50-kn winds with hail showers. A ship west of the island had 26-ft swells. The LOW turned westward late on the 3d, and by the 4th the 26-ft swells had moved 300 mi eastward. The storm was weakening over the Kamchatka Peninsula on the 5th.

Tropical Cyclones--Typhoon Mary, a late-season storm, was detected on the 21st near 10°N, 179°E. She developed as she moved toward the west-northwest. By the 23d she was a typhoon. Winds reached a peak for the next few days (fig. 72). On the 25th they blew at 95 kn with gusts estimated at 115 kn. During this time Mary was threatening the atolls of Kwajalein and Eniwetok. There was some evacuation but little reported damage. Mary moved southwestward between the two and then turned westward. By the 27th she had dropped back to tropical-storm strength and began her long journey across the tropical Pacific. Tracking mostly westward, Mary feinted toward Guam on the 29th, moved just north of Yap on the 31st, and finally crashed ashore in the central Philippines on January 2. She dissipated quickly among the islands.

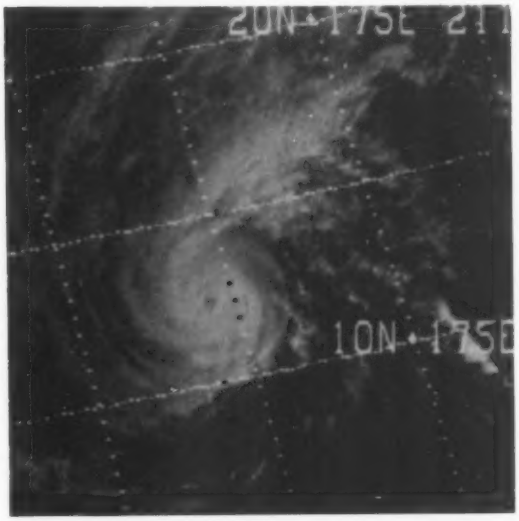


Figure 72.--Generating 75-kn winds, Mary was near her peak late on the 24th.

Casualties--The American container vessel PRESIDENT PIERCE (21,475 tons) encountered heavy weather on the 5th between Kobe and Seattle and lost containers overboard. The 35,545-ton Greek PANTELIS A. LEMOS arrived Yokohama on the 8th and reported heavy weather damage. The 16,700-ton

Indian ALEXANDRA N. reported heavy weather damage, on the 9th, that occurred earlier and had required temporary repairs at British Columbia. The 28,312-ton Liberian-registered tanker MICHAEL J. GOULANDRIS sustained heavy weather damage from the 10th to the 12th to forecastle, bow plating, and deck fittings.

Severe weather, language problems, and damage to the rescue ship hampered efforts to save the foundering 8,922-ton MALAYSIA PERMAI about 360 mi northwest of San Francisco on the 20th. The 17,807-ton HAWAIIAN MONARCH pulled alongside but could not transfer the crewmembers because of high winds and heavy seas. The ship with a crew of 33 had reported taking on water, but it appeared to be in no danger of sinking.

ROUGH LOG, JANUARY 1978--There were more storms across the ocean this month than normal. The location of the primary paths was near normal in pattern and orientation. The primary path of the cyclone centers was from Japan eastward to midocean. There was also a branch from off Japan into the Bering Sea. There were fewer storms than normal that moved into the Gulf of Alaska, but there were more that tracked onto the west coast of North America near Vancouver Island.

The primary mean-pressure feature was the Aleutian Low at 987 mb near 50°N, 176°E. Climatology shows a 999-mb center near 50°N, 170°E. The Pacific High was smaller and weaker than normal at 1019 mb versus 1020 mb, and it was 600 mi southeast of its usual position.

A large 15-mb negative anomaly was also a principal feature. In general the ocean from 30°N to the Bering Strait had negative pressure values.

The upper air flow pattern at 700 mb was quite different from the climatic pattern in that a 2,661-m LOW height center was near 51°N, 176°E, and the normal circulation center was still over the Sea of Okhotsk. There was a trough that paralleled the Asian coast. A large, sharp ridge dominated the North American west coast and Alaska.

There was one tropical cyclone, Nadine, in the western North Pacific early in the month.

Extratropical Cyclones--The first storm of the month originated in the climatological area of cyclogenesis off Japan. In any other month it probably would have qualified for the "monster of the month." In a matter of a few hours it was a well-developed storm. A British ship near 34°N, 149°E, about 200 mi southwest of the storm center had 50-kn winds and 20-ft waves. A Japanese ship farther away also had 20-ft waves. At 0000 on the 4th the 976-mb center was near 39°N, 167°E. Two ships reported 54-kn winds. At 0600 the ASIA BOTAN (40°N, 172°E) had 54-kn winds. A ship southeast of her had 19-ft seas and swells. Twenty-four hours later at 0000 on the 5th, the FEDSTEEL (38°N, 178°W) had 28-ft seas and swells which increased to 34 ft by 0600, and the VAN CONQUEROR (40°N, 172°W) fought 60-kn winds. There were several reports of 15- to 20-ft seas. The Indian cargo vessel CHANDRA GUPTA with 64 crewmembers, 4 wives, and 2 children radioed that it had lost the No.1 hold cover and was taking on water. At 1730 on the 5th the ship was abandoned while 500 mi northeast of Midway Island. The seas were reported as 25 to 30 ft. That night search aircraft spotted the vessel, but the next morning neither the vessel nor any survivors could be found. A lifeboat, jackets, and debris were found. This was one of the worst death tolls in many years. Starting on the 5th at 1800 and continuing for the next 24 hr, there were some very high winds and waves. The STREAM RUDDER reported 39-ft seas and 66-ft swells with 60-kn winds near 37°N, 164°W. At 0000 on the 6th her message read 49-ft seas and 59-ft swells. Other ships, including the FEDSTEEL, SUGAR CARRIER, and ZIM MONTREAL had winds of 50 to 60 kn and seas and/or swells to 40 ft. An American ship that could not be identified near 36°N, 165°W, also reported 51-ft seas. These reports were roughly in the area of 31° to 44°N and 160° to 175°W. At 0000 on the 6th the LOW was 960 mb near 43°N, 162°W (fig. 73). On the 7th all the reported waves were below 30

Figure 73.--Again the reports of high winds and waves were associated with scattered to broken cumulus-type clouds with a cellular structure.

Figure 74.--Homes on the beach at Malibu, Calif., take a beating from high waves that pounded the coast. Waves up to 7 ft hit the area for 2 days. Wide World Photo.

ft, but the FEDSTEEL found 76-kn winds. On the 8th there were two reports of swells up to 38 ft southwest of the center. On the 9th the LOW was filling rapidly as it entered the Gulf of Alaska. A ship off the Oregon coast found 60-kn southeasterlies, while another off Dixon Entrance had 25-ft swells from the southeast. The storm dissipated on the 10th.

A short-wave trough was moving around a LOW over the Sea of Okhotsk on the 6th. After the trough crossed Honshu, a LOW formed near 39°N, 148°E. Immediately it was caught in the upper air zonal flow and raced eastward. At 1200 on the 7th there were two reports of winds near 55 kn west of the center. On the 8th the LOW passed 500 mi north of the TACOMA MARU, who was pounding into 26-ft swells. On the 10th a Japanese ship reported 94-kn winds with 30-ft seas and swells about 450 mi southwest of the 976-mb LOW. Another ship about 250 mi farther away had 33-ft swells. At this time a secondary LOW formed off the California coast and hit the southern shore with high winds and waves causing flooding and damage to beach homes (fig. 74). A British ship about 300 mi off Los Angeles had southerly 20 ft seas and westerly 33-ft swells. On the 11th the AL DHAFRAH was east of the storm with 66-kn easterly winds. Late in the day two other LOWs absorbed the circulation.

The Sea of Japan was the birthplace of this storm. It moved across Honshu on the 9th and really started to intensify on the 10th. A German ship at 35°N, 149°E, soon found 23-ft waves southwest of the 978-mb LOW. On the 11th the MARITIME ACE (29°N, 149°E) had 31-ft swells and the TACOMA MARU (32°N, 153°E) 28-ft swells. The TEKNOLOG (45°N, 148°E) was blown by 66-kn winds. The PRESIDENT PIERCE (43°N, 180°) was near the occlusion with 50-kn winds, 23-ft seas, and 33-ft swells. At 1800 the LOW had plunged to 950 mb (fig. 75). On the 12th there were several high-

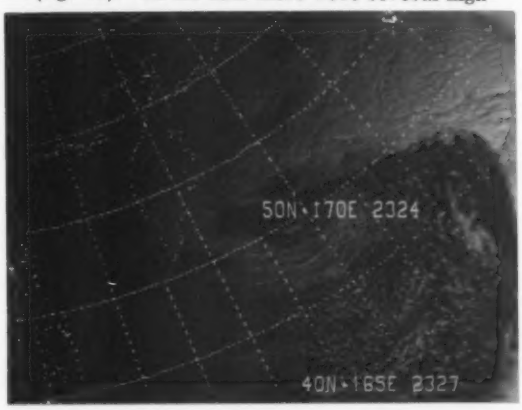


Figure 75.--The storm is centered near 50°N, 170°E, at the time of this satellite image on the 11th.

wind reports and seas to 20 ft.

On the 12th and 13th a secondary LOW moved from the west to the south side of the storm but dissipated after midday. This increased gradient south of the LOW increased the winds far to the south, and there was a 33-ft swell report near 28°N, 162°E. At this same time the cyclone center became stationary near 53°N, 173°E. The OGDEN TIBER was sailing southeastward near 48°N, 163°E, on the 14th with 26-ft seas and 30-ft swells on her stern. Six hours later the winds were 50 kn and seas and swells 39 ft. The cyclonic circulation and front stretched southward to latitude 20°N. Isolated high winds and seas continued until late on the 16th, when another cyclone took over.

This storm was the combination of two storms which joined forces some distance off the California coast. A series of LOWs had formed and dissipated on the edge of a stationary cyclone over the Gulf of Alaska. This came into being on the 11th near 32°N, 150°W. Since there was already a cyclonic circulation over the area, it did not take long for high seas and swells to develop. The TAIWAN PHOENIX fought 30-ft seas and swells near 29°N, 154°W. The CALIFORNIAN was a few miles to the east with 60-kn winds and 23-ft swells. On the 12th a ship northwest of the 978-mb center had 28-ft confused seas.

Late on the 12th another LOW formed to the northwest on the old occluded front of another LOW. On the 14th (fig. 76) the PESTOVO, southwest of the two

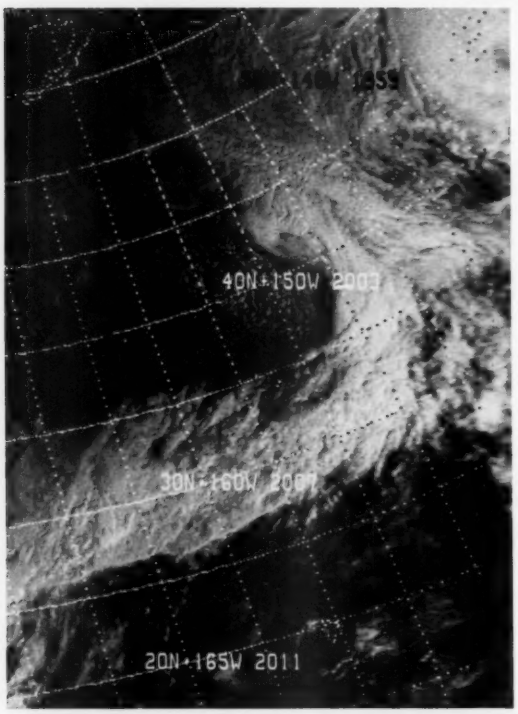


Figure 76.--Under this cloud deck there are two low-pressure centers and a frontal wave.

centers near 39°N, 151°W, pounded into 45-kn gales and 33-ft seas. At 1200 the two centers combined. Two ships in the vicinity of 40°N, 145°W, had 60-kn winds and swells as high as 39 ft. On the 15th the ANCO EXPRESS was stationary near 39°N, 144°W, probably waiting for the 33-ft swells to subside. On the 15th the LOW was absorbed by another as it raced into the area from the west. This new LOW and another which followed brought 50- to 55-kn winds and up to 20-ft seas to the area before a large cyclone centered over the Aleutians became the dominant circulation.

A cyclone developed in an area of flat gradient west of the Sea of Japan on the 14th. As usual, it increased in size and intensity as it crossed the Kurile Islands over the warmer waters of the Pacific. The first storm wind report was at 0600 on the 16th. On the 17th the 956-mb LOW was near 46°N, 169°E, and the PRESIDENT POLK was being pounded on the starboard side by 50-kn winds and 28-ft seas. A ship 250 mi south of the center had 33-ft seas, and another ship very near the center with 962-mb pressure had 23-ft swells. The HAKUSAN MARU registered a pressure of 960.5 mb 12 hr later. The VAN WARRIOR (46°N, 170°E) had 70-kn winds with no seas reported. One hundred miles closer to the LOW another ship had 65 kn.

The LOW was 963 mb on the 19th centered near Unimak Island. The GEORGE WALTON was about 1,400 mi southeast of the storm's center with 70-kn winds. The MONTEREY was 20° of longitude to the east also with 70-kn winds. The swell waves of 20- to 30-ft were in a band averaging 1,200 mi from the center and from the southwest to the southeast. On the 20th the center turned northwestward and filled rapidly as another storm approached from the southwest.

This storm was one of seven that originated off the Japanese coast. Within a few hours it was producing storm-force winds and waves to 30 ft on the 21st. At 1200 on the 22d the LOW was 962 mb near 43°N, 150°E. In the area bounded by the center, 30°N, 145°E, and 155°E, there were many wind reports of 50 kn or greater and seas and swells up to 30 ft. The 0600 and 1200 collective had 23 reports. The PINK SKY (40°N, 146°E) had 65-kn winds and 35-ft seas and swells. Severe weather reports continued into the 23d, with the GOLDEN BEAR near 42°N, 150°E, transmitting 50-kn winds, 33-ft seas, and 49-ft swells. On the 24th the wind intensity decreased, but the high swells continued. The LOW was now 964 mb. On the 25th the storm crossed into the Bering Sea and quickly perished.

The Yellow Sea contributed this storm. On the 24th it was south of Tokyo and rapidly expanding. On the 25th there were winds over 50 kn and seas and swells up to 20 ft. A Japanese ship near 35°N, 154°E, had quartering 64-kn winds. The HONG KONG PHOENIX (37°N, 164°E) and the ILLINOIS (45°N, 156°E) had 50- and 55-kn winds and 30- and 33-ft seas and swells, respectively, on the 26th. Winds and waves of 50 to 60 kn and up to 33 ft continued through the 27th. On the 28th the storm was moving northwestward and weakening rapidly.

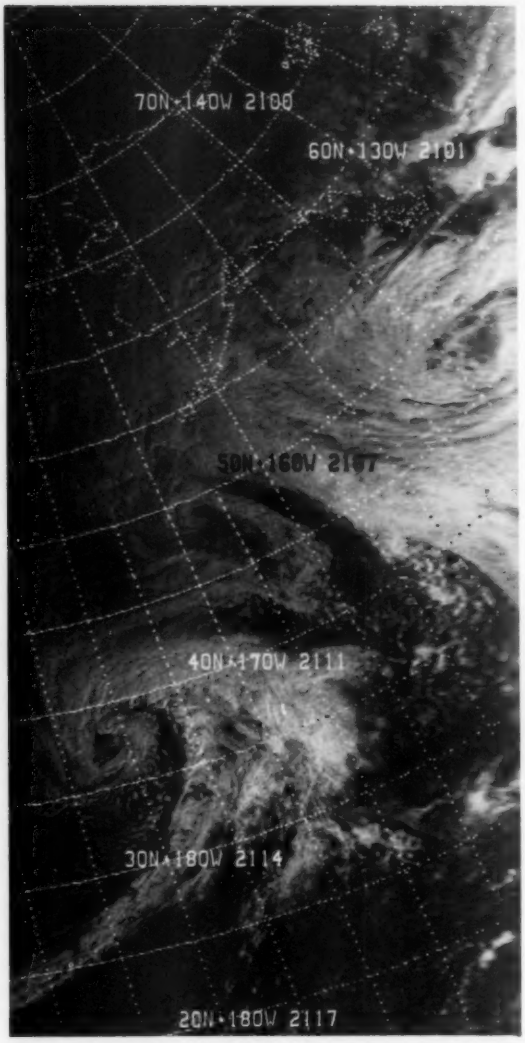


Figure 77.--Three hours prior to the high-wave report the satellite image shows the upper air cloud center near 38°N, 178°E, approximately due north of the LONG BEACH.

A shallow LOW could be traced from the Mongolian Desert to the Yellow Sea. It was over the Yellow Sea where intense cyclogenesis and frontogenesis took place on the 26th. Two ships had 50- to 60-kn winds off Tokyo over the Japan Trench early on the 27th. At 0600 the ILLINOIS was north of the 982-mb center with 50-kn northeasterly winds and 30-ft swell waves. Winds of 50 to 60 kn with waves to 33 ft were found on the 28th. The LOW was intense, but its circulation was not spreading over as large an area as the previous LOWs. As with other storms in this series, the LOW turned northwestward on the 31st and deteriorated into a trough by February 1.

Back to frontal waves. This wave appeared on the 0000 chart of the 29th south of Tokyo. It was the fourth and westernmost of a series of frontal-wave cyclones that stretched across the Pacific. On the 30th the EDEN MARU was south of the 976-mb center with 60-kn winds. Another ship not far away was sailing into 23-ft seas and swells. The storm passed about 120 mi north of the LONG BEACH at 1800, and at 0000 on the 31st (LONG BEACH - 36°N, 178°E; storm - 38°N, 178°W) she had 60-kn winds (fig. 77). The wave report was 32445. This could have been either a sea or swell report as the wind was from 320°, the period could have been either 14 or 24 S and the height still works out at 74 ft. There were other wave reports of 20 to 30 ft in the area so that height seems far out, but odd things happen over the ocean and there are often powerful local forces at work. A report on February 1 by the SEA LAND MCLEAN (38°N, 171°W) in the same general relationship to the center of 52-ft seas and swells with 60-kn winds gives some credence to the 74 ft. On the 2d the storm curved northward and became stationary near 46°N, 160°E, where it was absorbed by another storm.

Tropical Cyclones--Nadine came together on the 8th about 150 mi south of Eniwetok. As a tropical storm she passed west of the atoll on the 10th. Continuing northward (fig. 78), Nadine generated 40- to 45-kn winds close to her center. On the 11th she swang to the east-northeast. Winds climbed to 55 kn the following day as Nadine turned northeastward and crossed the 170th meridian near the 20th parallel. By the 13th she was turning extratropical.

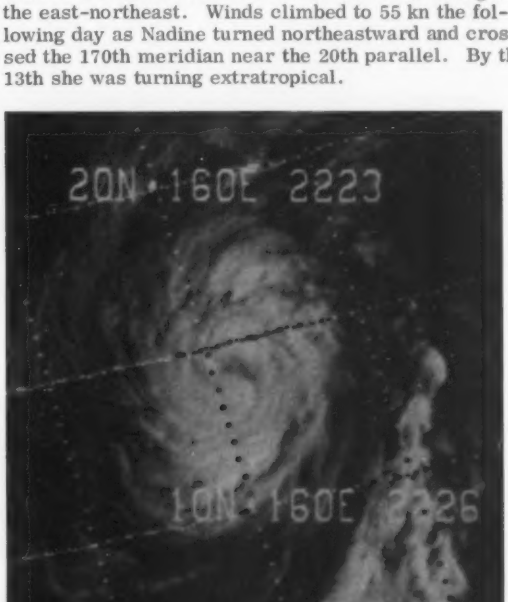


Figure 78.--Nadine blankets Eniwetok, which is south of the center on the 10th.

Casualties--The storm that produced the weather damage for some of these casualties may be described in the text, but the information available was not sufficient to determine the storm involved.

The 49,808-ton Greek tanker OCEAN VICTORY had heavy weather damage on the 5-7th including catwalks ladders, gangways, derrick, boom, piping, and guardrails. The British tanker(15,425 tons)ANCO EMPRESS encountered heavy weather 12th-17th. The 44,742-ton Greek bulkcarrier AGIOS NICOLAOS V from Vancouver to Durban reported on the 12th with heavy weather damage. On the same day the 8,242-ton Panamanian cargo vessel ELENA was at Kobe with damage to a crane. On the 13th, 11,192-ton Indian RATNAMANORAMA arrived Madras Roads with damage. Another Indian vessel, the 22,593-ton MARATHA PROVIDENCE, reported a hole in number 5 hold and required assistance because of heavy weather on the 24th.

The 13,037-ton Liberian cargo vessel SILVER PAGODA arrived Pusan on the 25th with a lost hold cover during heavy weather. The Liberian-registered JAPAN VENTURE (9,630 tons) at Miyako on the 26th with heavy weather damage.

The 71,763-ton Liberian tankship SANSINENA lies broken in the San Pedro, Calif., harbor after an explosion. Because of weather conditions, vapor fumes expelled while ballasting remained over the deck and ignited on December 17, 1976. U.S. Coast Guard Photo.

Marine Weather Diary

NORTH ATLANTIC, APRIL

WEATHER. During April, weather conditions over the middle and northern latitudes are generally much more settled compared to the preceding month. Thus, intervals of favorable weather are more frequent and usually of longer duration. There is a notable reduction in the frequency and intensity of winter-type LOWs. The 1007-mb Icelandic Low lies off Kap Farvel near 59°N, 41°W. The Azores High (1021 mb) is centered more than 1,700 mi farther south near 30°N.

WINDS. The prevailing wind north of 40°N is generally from the westerly quarter of the compass except over the Norwegian Sea, where winds are quite variable. Within this large belt, about 55 percent of the observations report winds of force 4 to 6. From about 40°N southward to the northern boundary of the trades, the prevailing wind is mostly southwesterly, although winds with an easterly component are prevalent off the east coast of Florida out to 70°W, and over the Gulf of Mexico. Near the coasts of Morocco and Portugal, northerly winds dominate, and westerly and northwesterly winds hold sway over the Mediterranean Sea. The winds north of the trades and south of the westerlies are weaker than their counterparts north of 40°N--only about 45 percent of all observations yield winds of force 4 to 6. The trades are more firmly entrenched in April, as compared to March. They usually prevail south of 25°N and, in the eastern North Atlantic, extend to about 30°N. Fifty to 75 percent of the time, they are force 3 to 4.

GALES. The area subject to gales decreases greatly in the middle and northern latitudes, compared to March. The most southern point of the 10-percent frequency boundary has moved northward to 53°N, 45°W. The area affected is enclosed by that point to 60°N, 15°W, to 62°N, 25°W, to 65°N, 28°W, to 63°N, 55°W, to 53°N, 45°W. A small area (about 6° square) of 10-percent frequency is centered east of the Grand Banks near 47°N, 38°W. Gales also spread over the Gulf of Lions about 10 percent of the time.

EXTRATROPICAL CYCLONES. Principal areas of cyclogenesis during the spring months (March, April, and May) are found in a broad area from Cape May down to Georgia on the United States east coast, east-northeastward out to the central ocean, including the waters around Newfoundland. Within this region, cyclogenesis is concentrated from the coasts of Virginia and North Carolina northeastward to a point near 39°N, 66°W. Other principal areas of cyclogenesis lie around the south coast of Iceland; over most of the Baltic Sea, including Danish waters, but not including the Gulf of Bothnia; off Norway's arctic coast; over the Bay of Biscay; and over the Gulf of Genoa, the northern and central Adriatic Sea, and the southwestern Black Sea. Primary storm tracks in April are much the same as in March. One track begins about 250 mi east of Cape May and travels northeastward over the Grand Banks. The storms heading northeastward across the North Atlantic tend to pass a little farther south of Iceland than in March. Over the Mediterranean, the primary storm track reaches northern Italy, but does not extend to southern Turkey as it did in March.

TROPICAL CYCLONES have not been reported during April in the North Atlantic in the past 104 yr. This is the only month of the year in which no tropical storm activity has occurred.

SEA HEIGHTS of at least 12 ft are found more than 10 percent of the time north of a line extending from Labrador around the eastern margin of the Grand Banks to 41°N, 50°W, westward to 70°W. The same line curves eastward along the 36th parallel to 60°W, and then across the North Atlantic to Ireland and central Norway. Another small area of 10-percent frequency extends from the Gulf of Lions southeastward to a distance of 150 mi out over the Mediterranean. An elliptically shaped area of 20-percent frequency extends from latitude 55° to 60°N, and across longitudes 15° to 55°W.

VISIBILITY. Occurrences of low visibility increase over the western part of the North Atlantic, especially west of 40°W. The greatest change from March takes place over the Grand Banks and the waters south and east of Newfoundland, where over 20 percent of the observations show visibilities of less than 2 mi. Visibility over the Norwegian Sea has decreased in the west and increased in the east. The area of 10-percent frequency of low visibility over the North Sea has moved southwestward and extends from the tip of southern Norway to the coast of Great Britain.

NORTH PACIFIC, APRIL

WEATHER. The weather over the North Pacific generally shows marked improvement over that of any month since October. Compared to the winter months, periods of storminess are fewer, but severe extratropical LOWs are still encountered occasionally. The Aleutian Low has filled to three 1009-mb centers along 55°N. Its configuration is that of a banana, bridging from the Gulf of Alaska to the Sea of Okhotsk. The 1012-mb isobar orientation has changed very little over the past months, except the southern boundary has moved steadily northward with spring, now approximating 50°N. The three LOWs are located just east of Kamchatka, in the middle of the Bering Sea, and in Bristol Bay. The Pacific High is expanding with two major centers near 32°N, 159°W, and 32°N, 178°W.

WINDS. Over about half of the North Pacific between 40° and 55°N, the windspeeds are of force 4 to 6 in 50 to 65 percent of the observations. The remainder of this latitudinal belt, especially near the coast of North America, experiences winds of force 3 to 5. The prevailing winds are from the westerly quarter. Between 30° and 40°N, winds are variable west of 170°E, mainly southwesterly between 170°E and 150°W, and westerly to northerly east of 150°W. Forces 3 to 5

are recorded in 45 to 70 percent of the observations. Variable force 5 winds often blow over the western half of the Bering Sea, and northerly force 5 winds are quite common over the eastern half. Easterly winds of about force 4 sweep over the northern Gulf of Alaska. South of Japan, easterly force 4 winds prevail, and winds from any direction except west and southwest are common over the East China Sea, where force 3 to 4 is the rule. The "northeast trades" prevail south of 25°N, over the western ocean between the dateline and the Philippines, and south to 30°N over eastern waters. The trades blow at about force 4, except near the Equator and over the Philippine Sea, where force 3 winds prevail. The northeast monsoon continues to dominate the South China Sea, but with less strength and steadiness than in the colder months. Winds of force 2 to 3 account for between 46 and 63 percent of all observations. Northerly winds continue to prevail south of the Gulf of Tehuantepec, but gales over the Gulf now occur less than 5 percent of the time. Force 2 to 3 winds are experienced 50 percent of the time, compared to 40 percent in March.

GALES. Two areas of high gale frequencies, 10 to almost 20 percent, persist as a residual of the winter month in the middle and northern latitudes. One holds sway over the Gulf of Alaska south of Kodiak Island to about 52°N, and eastward to near 140°W. The other is a belt 250 to 370 mi wide that lies east of Honshu from about 36°N, 147°E, northeastward to about 45° to 48°N, and 178°E.

EXTRATROPICAL CYCLONES. The principal area of cyclogenesis stretches from south of Kyushu northeastward to about 700 mi south of Beringa Island. A primary track from across Sakhalin Island combines with the one above and follows the Aleutian Islands into the Gulf of Alaska. About 180°, a branch shoots off to the northeast toward, and over, the Pribilof Islands. About midway between Hawaii and Adak, a track points northeastward toward Yakutat. A secondary cyclone path enters British Columbia near the southern tip of the Queen Charlotte Islands. The storm tracks have moved slightly northward over the western waters. The intensity of the storms has started to decrease, resulting in fewer gales.

TROPICAL CYCLONES. In an average 10-yr period, about seven tropical storms can be expected over Far Eastern waters. About 80 percent of these, or 4 out of 5, have developed to typhoon strength. Tropical cyclones develop in the same region as they did in March, east of the central and southern Philippines and west of 170°W, but the area affected by these warm-core storms has expanded northwestward to include the waters east of Luzon and around Taiwan. A tropical cyclone in the eastern North Pacific in April would be a rarity.

SEA HEIGHTS. The area where there is at least a 10-percent frequency of 12-ft, or higher, seas is roughly bounded by 155°E and 150°W on the west and east, 52°N on the north, 32°N on the southwest corner, and 45°N on the southeast. An area of 10-percent frequency of swells equal to, or greater than, 12 ft parallels the coastline of North America, including the Aleutian Islands, and joins the western half of the above area.

VISIBILITY. Reduced visibility (less than 2 mi) of 10-percent, or greater, frequency extends to the north of a line drawn from Sakhalin southeastward to about 40°N, 160°E, and then east-northeastward to about 45°N, 175°W. From there the line swings northward to Amlia Island in the eastern Aleutians, and then eastward to about 50°N, 150°W, before cutting back across the Alaska Peninsula to the Bering Sea, east of St. Lawrence Island. The area of 20-percent frequency has decreased in size since March and is now centered over the northern Kurils.

NORTH ATLANTIC, MAY

WEATHER over the North Atlantic continues to moderate during May. The Azores High builds slightly to a central pressure of 1022 mb near 31°N, 40°W, while the Icelandic Low centered several hundred miles southeast of Greenland's southern tip fills to about 1012 mb.

WINDS over the greater part of the ocean between 40° and 55°N are generally westerly, except northeasterly over the Baltic Sea, but with less persistence than earlier in the spring. The average windspeed north of 40°N is force 4. Winds are quite variable between 55° and 60°N and are generally northerly north of 60°N. Between 25° and 40°N, winds are somewhat lighter, generally of force 3. West of 40°W, within the above latitudinal belt, south and southwest winds tend to prevail; while east of this longitude, winds from the northerly quarter of the compass are by far the most frequent of all. Over Mediterranean waters, west-northwesterly winds of force 2 to 3 are the most common. The Gulf of Mexico plays host to easterly force 3 winds. The "northeast trades," force 3 to 4, dominate the wind regime between 5° and 25°N, except along the African coast, where they extend northward to about 30°N. South of 5°N to the Equator, the force 2 to 3 winds almost always have an easterly component.

EXTRATROPICAL CYCLONES continue to develop frequently from off the Carolina coast northeastward to Newfoundland, but are becoming less severe. The direction of movement from Newfoundland is generally either north toward the Davis Strait, or northeast toward the Norwegian Sea. Two primary tracks affect the Great Lakes. One runs east-southeastward from Lake Winnipeg to south of James Bay. Another follows a line from eastern Iowa across southern Lake Michigan and southern Lake Huron to lower Quebec. After meeting, the two tracks proceed as one to the Gulf of St. Lawrence.

GALES are rare below 40°N, and their frequency and duration in higher latitudes are less than in the preceding months. The area of maximum likelihood of gales, 10 to 20 percent, generally is located from the southern tip of Greenland southward to about 52°N, between 40° and 56°W.

TROPICAL CYCLONES are infrequent during May. During the 44-yr period 1931-77, nine tropical storms have occurred, and two of them attained hurricane force.

SEA HEIGHTS of 12 ft or more are encountered from 5 to 10 percent of the time along the northern shipping lanes, from several hundred miles east of the Chesapeake Bay to the northern Norwegian coast, excluding the North Sea and the Bay of Biscay, but including the Gulf of Lions southeastward to Sardinia. The frequency increased to more than 10 percent in the midocean area and to more than 20 percent south of Kap Farvel.

VISIBILITY limited to less than 2 mi is encountered 10 to 20 percent of the time over the western North Atlantic, from about 40°N, 65°W, northeastward to a point near 53°N, 30°W, and then westward to the Labrador Sea. The line, north of which frequencies are greater than 10 percent, but less than 20 percent, then extends northeastward over Kap Farvel to north of Iceland, and through the Norwegian Sea to the Barents Sea. Visibility less than 2 mi also occurs between 10 and 20 percent of the time over a great part of the northeastern North Sea. Frequencies increase to over 20 percent of the time over the Grand Banks and off the southwest coast of Greenland.

NORTH PACIFIC, MAY

WEATHER continues to improve slowly over the North Pacific in May. The subtropical High has an average central pressure of about 1022 mb and is located near 34°N, 152°W. The Aleutian Low becomes a broad weakening trough extending from the Asian mainland eastward to the western Gulf of Alaska. The lowest pressure, about 1008 mb, is centered over the west-central Bering Sea.

WINDS north of the 25th parallel tend to come from the westerly quarter of the compass, but variable winds are present over a number of locations on either side of the dateline. Winds over the Gulf of Alaska are easterly at force 3 to 4. Along the coast of the United States, northwesterly components are pronounced. Between the Equator and 25°N, (30°N, east of 180°), the "northeast trades" are very steady, except over the southern half of the South China Sea, where southerly winds of the southwest monsoon have established themselves. These monsoon winds are usually force 2 to 3, though lighter winds are not unusual. Over most of the rest of the North Pacific, windspeeds average force 3 or 4. Northerly and westerly winds prevail out from the Gulf of Tehuantepec, with easterly and northwesterly winds close behind. Speeds are force 2 or 3, 48 percent of the time.

EXTRATROPICAL CYCLONES continue to develop over the Ryukyus and then move east-northeastward toward the Gulf of Alaska. A second primary storm track crosses the Siberian coast and Sakhalin, continues eastward across the northern Kuril Islands, and then curves toward the southern Bering Sea.

GALES decrease in frequency. In midocean between 40°N and the Aleutians, the chance of encountering gale-force winds remains slightly above 5 percent. Two smaller areas of similar frequency are found near the Alaska Peninsula and over the southern part of the Gulf of Alaska.

TROPICAL CYCLONES. Tropical storms occur, on the average, slightly more than once each year over the western ocean. There have been some years with none, but some with as many as four. Roughly 75 percent of these tropical storms become typhoons. The areas of most frequent development are south of 20°N, from the Carolines westward across the Philippines and the South China Sea. About once every 2 yr, a tropical storm or hurricane develops over the ocean area off Mexico during May.

SEA HEIGHTS. Seas of 12 ft or more continue to decrease in frequency as the winds decrease. The area of 10 percent or greater has the shape of a long balloon squeezed in the middle. The northern boundary parallels the Aleutian Islands about 400 mi to the south, between 160°E and 148°W. The southern boundary is 40°N over the western, and 45°N over the eastern ocean. High swells continue to be observed off the Asian and northern coasts, with a larger area in midocean very roughly bounded by 30° and 50°N, 155°E and 170°W.

VISIBILITY less than 2 mi occurs more than 10 percent of the time over the western North Pacific Ocean north of 35°N, and over the eastern North Pacific Ocean north of 42°N and west of 140°W, excluding the Gulf of Alaska and the waters southeast of the central Aleutians. Over the northern Kurils, this low visibility occurs more than 30 percent of the time.

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